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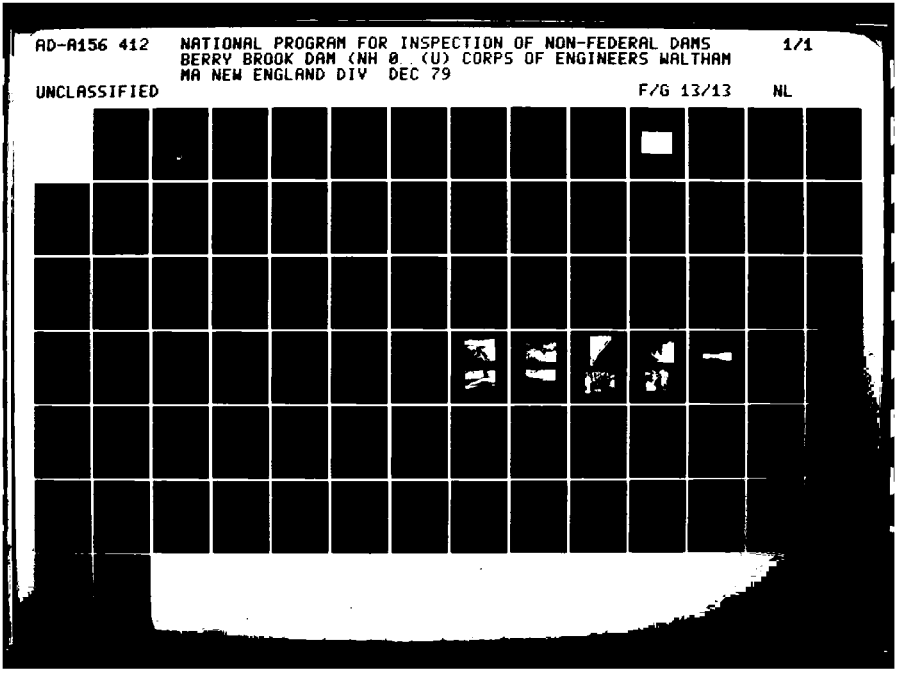

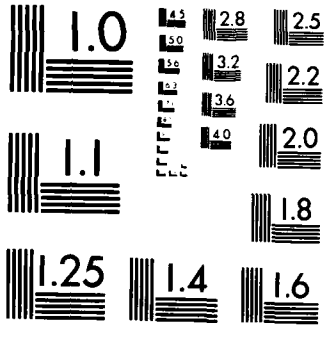

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PISCATAQUA RIVER BASIN
FARMINGTON, NEW HAMPSHIRE

BERRY BROOK DAM
NH 00313

STATE NO 83.06

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1979

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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Piscataqua River Basin
Farmington, New Hampshire
Berrys River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a concrete gravity dam with a hydraulic height of 24 ft. and in 269 ft. long. The dam is in fair condition. There are a few concerns which should be remedied. It is small in size with a significant hazard potential. A major breach at top of dam would probably result in no loss of lives but could cause appreciable property damage.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

APR 2 8 1980

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Berry Brook Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, the city of Rochester.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00313
Name of Dam:	Berry Brook Dam
Town:	Farmington
County and State:	Strafford, New Hampshire
Stream:	Berrys River
Date of Inspection:	October 25, 1979

BRIEF ASSESSMENT

Berry Brook Dam is a concrete gravity dam with a hydraulic height of 24 feet and totaling 269 feet in length. The spillway is 128 feet long, 2 feet wide at crest, with a sloping (1H:1V) downstream face. A gatehouse is located atop the east spillway abutment and houses the operating mechanisms for a 14-inch high-level outlet pipe and a 24-inch low-level outlet pipe. A dike, with a concrete core wall 43 feet in length, is located 150 feet west of the west abutment of the dam. The dam impounds a reservoir with a maximum storage capacity of about 200 acre-feet. The reservoir is 0.25 mile in length with a surface area of about 15 acres, and is an upstream regulating reservoir for use in the water supply system for the City of Rochester. The dam is located centrally near the eastern boundary of the State of New Hampshire.

The dam is in fair condition. Concerns are the spalling and erosion of the downstream face and construction joint of the training wall at the east end and the construction joint of the concrete spillway, the large birch tree growing out of the retaining wall on the east bank, and the overhanging trees and brush in the downstream channel.

Based on small size and significant hazard classification the allowable range for the test flood is from the 100-year to ½ Probable Maximum Flood (PMF) in accordance with the Recommended Guidelines for Safety Inspection of Dams. The test flood selected is ½ PMF. The watershed is moderately to steeply sloping and wooded with numerous small storage areas present. The test flood inflow was determined to be 775 cfs. Routing of this inflow to determine the modifying effects of surcharge storage resulted in an insignificant reduction. The routed test flood outflow for Berry Brook Dam, having a drainage area of 3.1 square miles, was determined to be 775 cfs (250 csm) at elevation 478.6' NGVD. Spillway capacity at top of dam is 1255 cfs which is 162 percent of the routed test flood outflow. A major breach at top of dam would probably not result in the loss of any lives but could cause appreciable property damage.

The owner, City of Rochester, should implement the results of the recommendation and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I Inspection Report.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Berry Brook Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

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APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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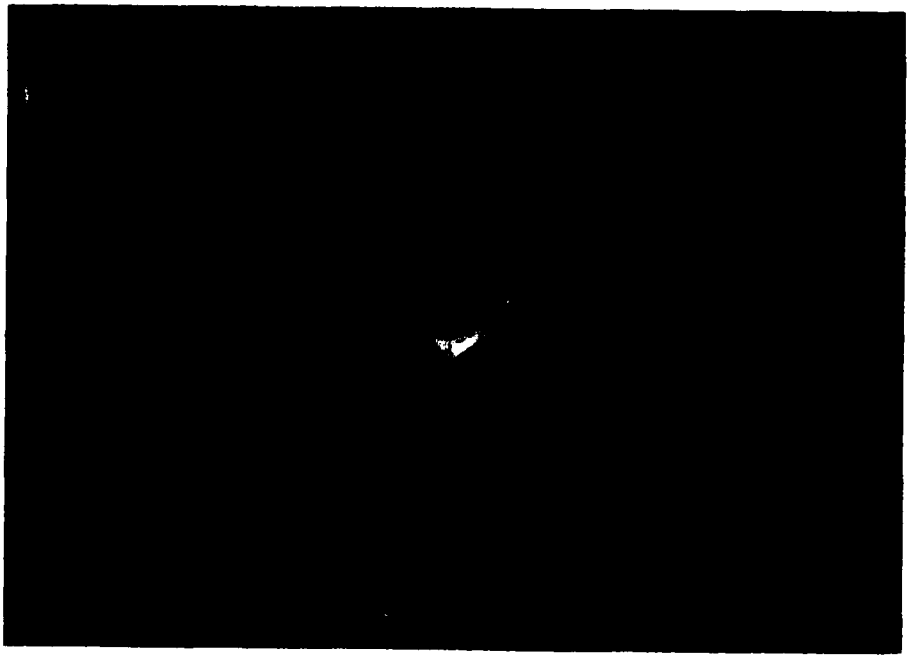
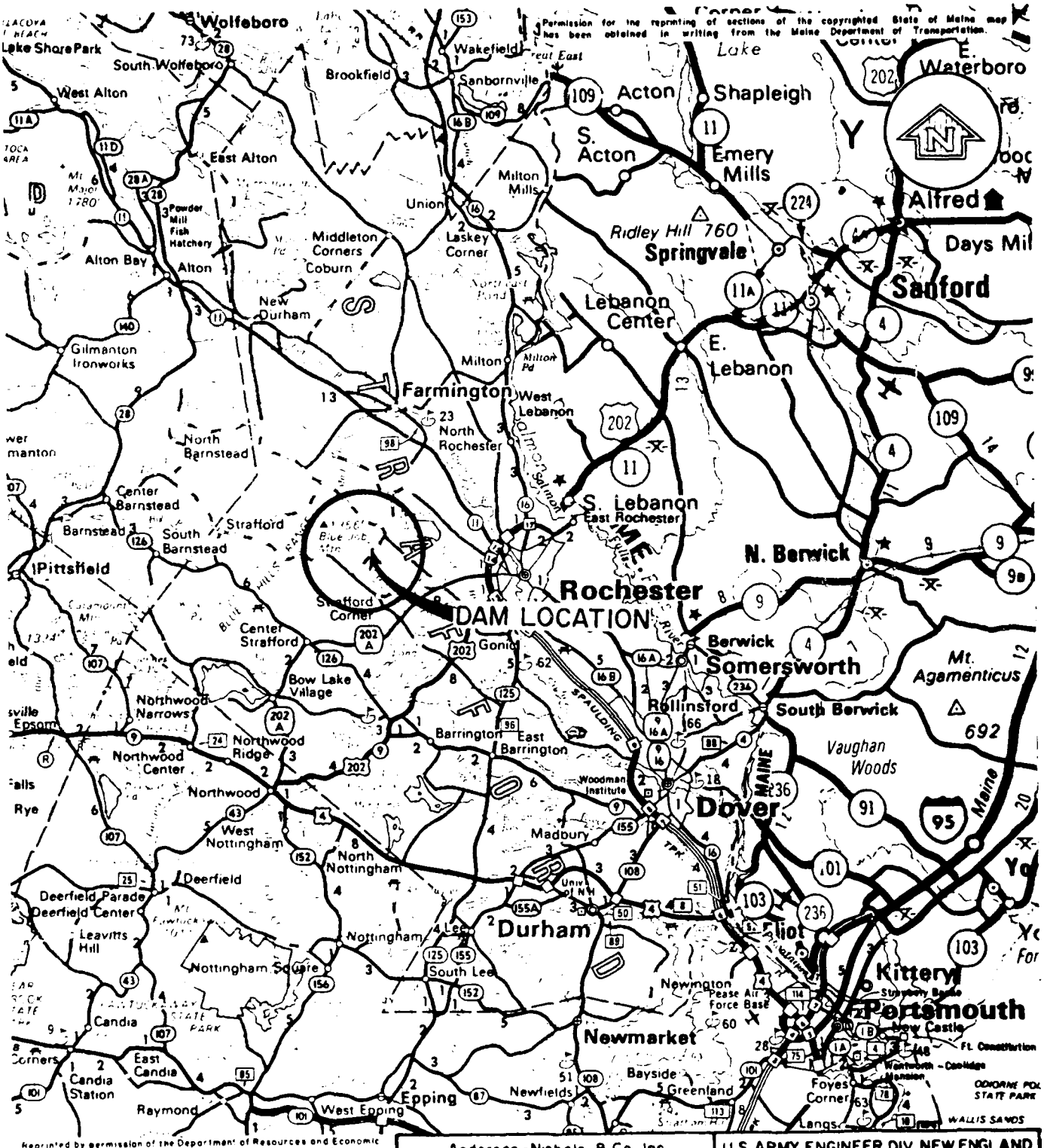


October 1979

Figure 1 - Overview of Berry Brook Dam.



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SCALE IN MILES

5 0 5

MAP BASED ON STATE OF NEW HAMPSHIRE - STATE OF MAINE OFFICIAL HIGHWAY MAPS

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BERRY BROOK DAM
LOCATION MAP

BERRYS RIVER NEW HAMPSHIRE

			SCALE: 1" = 5 Mi.
			DATE: DECEMBER 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
BERRY BROOK DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of March 22, 1979 from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0050, as changed, has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Berry Brook Dam is located in the Town of Farmington, New Hampshire and impounds a reservoir of a small size on Berry's River. After discharging at damsite, Berry's River flows into Rochester Reservoir 3.1 miles downstream of the dam. Howard Brook flows out of the Rochester Reservoir and converges with Rickers Brook 1.7 miles downstream to form Axe Handle Brook. Axe Handle Brook flows 2.2 miles to its confluence with the Cocheco River, a major tributary in the Piscataqua River Basin. The dam is shown on U.S.G.S. 15-Minute Quadrangle, Alton, New Hampshire, with coordinates approximately at N 43° 18' 56", W 71° 04' 56", Strafford County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Berry Brook Dam is a concrete gravity dam, with a hydraulic height of 24 feet, and totaling about 269 feet in length. The east abutment of the dam consists of a concrete wall 2.2 feet in width and about 102 feet in length. This wall extends east 42 feet to a change

in alignment and then extends northeast 60 feet. A 12-foot gatehouse is constructed on the east spillway abutment. This gatehouse contains the operating facilities for a 24-inch low-level outlet pipe and a 14-inch high level outlet pipe. A concrete retaining wall extends downstream of the gatehouse and contains the high and low-level outlet pipes. The east abutment ties into a graveled roadway which runs perpendicular to the dam. The spillway is concrete gravity, 128 feet in length, with a sloping downstream face (1H:1V). The west spillway abutment is 39 feet in length, 2.2 feet wide, and ties into natural ground.

A dike is located 150 feet west of the dam. The dike is 43 feet long and has a 1-foot wide concrete core wall along its entire length. The crest elevation is 2.2 feet above the spillway crest. The dike itself is about 3 feet in height. The upstream and downstream slopes are 3H:1V.

c. Size Classification. Small (hydraulic height - 24 feet; storage - 200 acre-feet) based on storage ($\geq$ 50 to $<$ 1000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A breach at top of dam would probably not result in loss of life, but could cause appreciable property damage. The loss of this reservoir would result in the loss of the upstream regulating reservoir for use in the water supply for the City of Rochester and would therefore interrupt the services of a public utility. (See Section 5.1 f.)

e. Ownership. The dam was built in 1930 by the Rochester Water Works within the City of Rochester's Public Works Division for the purpose of creating an upstream regulating reservoir for use in the water supply. It is presently owned by the City of Rochester and administered by the Public Works Division.

f. Operator. The current operator of the dam is the Rochester Public Water Works Division, Rochester, New Hampshire 03867. Phone: (603) 332-4096.

g. Purpose of Dam. The dam was built to provide a regulating reservoir for use in water supply to the City of Rochester, New Hampshire.

h. Design and Construction History. Two sheets of plans were found for Berry Brook Dam. One was entitled "Plan of Proposed Dam on Berry Brook" to be constructed by Rochester Water Works, designed by G.D. Dame, Engineers, 1930. These were the design plans for the dam. The other plan entitled "Plan of Dam on Berry Brook" drawn by the same engineer and dated 1930 is a plan of the dam as constructed. Construction was performed by the Rochester Water Works. No construction records were disclosed.

i. Normal Operating Procedures. Two outlet pipes, one 14-inch and one 24-inch were noted by visual inspection. According to Rochester's Public Works Division only the 24-inch pipe is operated for the water supply. When the water behind the dam falls below the 24-inch pipe level the outlet is closed. When the water level rises above the outlet elevation it is reopened. This pipe discharges water into the downstream channel which empties into the Rochester Reservoir. No formal or written maintenance program was disclosed. However, the dam is visited often and conditions are checked. Maintenance is performed on an as needed basis.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 3.1 square miles (1984 acres) of moderately to steeply sloping mostly forested terrain. The normal pool has a surface area of 15 acres which constitutes less than 1 percent of the watershed. Numerous storage areas, including the largest, Oxbow Pond, are present in the upstream watershed.

b. Discharge at Damsite.

(1) Outlet works (conduits) - one 14-inch pipe @ invert elevation 462.1' NGVD; discharge capacity at spillway crest - 26 cfs @ 477.0' NGVD. One 24-inch pipe @ invert elevation 455.6' NGVD; discharge capacity at spillway crest - 90 cfs @ 477.0' NGVD.

(2) The maximum discharge at the damsite is unknown.

(3) Ungated spillway capacity at top of dam - 1255 cfs @ 479.2' NGVD

(4) Ungated spillway capacity at test flood elevation - 775 cfs @ 478.6' NGVD

(5) Gated spillway capacity at top of dam - not applicable

(6) Gated spillway capacity at test flood elevation - not applicable

(7) Total spillway capacity at test flood elevation - 775 cfs @ 478.6' NGVD

(8) Total project discharge at test flood elevation - 775 cfs @ 478.6' NGVD

c. Elevation (ft. above NGVD of 1929; formerly called Mean Sea Level (MSL); see (6) below).

(1) Streambed at centerline of dam - 455.6 (downstream invert low-level outlet)

(2) Maximum tailwater - unknown

(3) Upstream gate inverts - unknown

(4) Recreation pool - not applicable

(5) Full flood control pool - not applicable

(6) Spillway crest - 477.0 (estimated from USGS Quadrangle)

(7) Original design surcharge - unknown

(8) Top of dam - 479.2 (dike crest elevation)

(9) Test flood pool - 478.6

d. Reservoir Length (miles)

(1) Maximum pool - .30

(2) Spillway crest pool - .25

(3) Flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - not appliable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 160

(4) Top of dam - 200

(5) Test flood pool - 190

f. Reservoir Surface Area (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest - 15

(4) Test flood pool - 20 (estimated)

(5) Top of dam - 22 (estimated)

g. Dam

(1) Type - concrete gravity dam

(2) Length - 269'

(3) Height - 24' (structural)

(4) Topwidth - 2.2 (concrete abutments)

(5) Side slopes - upstream, vertical; downstream, sloping.

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable

(See j. below.)

i. Spillway

(1) Type - concrete gravity spillway with a sloping downstream face (1H:1V).

(2) Length of weir - 128'

(3) Crest elevation - 477.0' NGVD (See 1.3 c (6) above)

(4) Gates - none

(5) U/S Channel - Berry's River. No structures are located on the reservoir slope. The banks are heavily wooded. The eastern side of the lake is paralleled by a gravelled road for 0.1 of a mile.

(6) D/S Channel - Immediately below the spillway the channel is about 6 feet wide with a rocky bottom and heavily wooded overbanks. A small wooden bridge is located about 100 feet downstream of the dam. A stone box culvert is located about 300 feet downstream of the dam and carries a gravel road. Downstream of this road crossing is a large swampy area which extends to the State Route 202A crossing that is located 2 miles downstream of the dam.

j. Regulating Outlets. Two outlet pipes, one 14" with an invert elevation 462.1' NGVD and one 24" with an invert elevation 455.6' NGVD are located below the gatehouse on the east abutment of the dam. The mechanical operating facilities for these pipes are located above the openings. Each pipe has its own mechanical operating mechanism.

SECTION 2
ENGINEERING DATA

2.1 Design

Two sheets of plans were found for Berry Brook Dam. One was entitled "Plan of Proposed Dam on Berry Brook" to be constructed by Rochester Water Works, designed by G.D. Dame, Engineers, 1930. These were the design plans for the dam. The other plan entitled "Plan of Dam on Berry Brook" drawn by the same engineer and dated 1930 is a plan of the dam as constructed. No construction records were disclosed. Blueline copies are on file in the New Hampshire Water Resources Board (NHWRB).

2.2 Construction

No records of construction were disclosed.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. A search of the files of the New Hampshire Water Resources Board and direct contact with the owner revealed a limited amount of recorded engineering information.

b. Adequacy. The final assessments and recommendations of this investigation are based primarily on visual inspection, the hydrologic and hydraulic calculations and the plans in NHWRB files.

c. Validity. The structure, as seen at the time of the visual inspection, is generally consistent with the 1930 as-built plans by the G.D. Dame, Engineers.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Berry Brook Dam impounds a reservoir of small size. The watershed above the reservoir is moderately to steeply sloping and heavily wooded. The downstream area is flat to moderately sloping and heavily wooded.

b. Dam. Berry Brook Dam is a concrete gravity dam with a hydraulic height of 24 feet, 269 feet long, and 2.2 feet wide at the crest of the abutments. (See Appendix C - figure 2.) Earthfill has been placed against the upstream and downstream sides of the concrete gravity section between the east end of the overflow section and the east abutment. (See Appendix C - Figure 3.) The earthfill is covered with grass which has been mowed. One large pine tree is growing in this fill near the east abutment. (See Appendix C - Figure 2.) A number of small trees are growing on the west abutment. (See Appendix C - Figure 4.) No evidence of seepage through the abutments was observed. A gravelled roadway runs perpendicular to the dam east of the east abutment. (See Appendix C - Figure 5.)

Available records indicate that the dam is founded on "ledge". Extensive bedrock exposures in the west bank of the discharge channel immediately downstream of the dam are consistent with these records. (See Appendix C - Figure 6.) Water was discharging over the overflow section of the dam at the time of the inspection and, consequently, it was not possible to observe whether any leakage was taking place through the foundation of the dam. The report of an inspection made on 7/31/50 indicates that "minor seepage under spillway on ledge foundation" was occurring at that time.

A dike is located 150 feet west of the west abutment. (See Appendix C - Figure 7.) The crest consists of a one foot wide concrete wall. The upstream and downstream slopes are earth and slope at 3H:1V.

c. Appurtenant Structures.

(1) The concrete spillway, 128 feet long and 2 feet wide at the crest, is surface eroded with minor erosion at the vertical construction joints to a depth of approximately one-half inch. With the water flowing over the crest it was not possible to inspect the downstream face of the weir. Considerable debris has collected on the crest of the spillway. (See Appendix C - Figure 2.)

The downstream face of the east training wall has considerable surface spalling and efflorescence. (See Appendix C - Figure 8.) The construction joint at the break in the wall is eroded to a depth of approximately 3 inches. Also, three areas on the face are seeping and were wet at the time of the inspection. The joint material in the construction joint was observed to be deteriorated and eroded.

(2) The control tower, which is constructed integrally with the concrete dam and spillway, was observed to be in good condition. Only minor surface spalling was observed on top of the concrete walls. The wooden building, which houses the gate operating equipment, was observed to be weathered on the exterior with no indication of structural deterioration. The gate operating mechanism could not be inspected because the gatehouse was locked.

(3) The downstream outlet structure walls were observed to be in good condition except for some minor spalling of the concrete face at the construction joint approximately 6 feet down from the top. (See Appendix C - Figure 8.) The two outlet pipes could not be inspected because of the limited accessibility. A large birch tree is growing out of the fieldstone retaining wall on the east bank of the channel immediately downstream of the gatehouse. (See Appendix C - Figure 9.)

(4) The exposed portion of the dike core wall was observed to be in good condition with no indication of deterioration or movement.

d. Reservoir Area. The watershed above the reservoir is moderately to steeply sloping and is heavily wooded. (See Appendix C - Figure 10). No structures were observed on the shore of the reservoir. No evidence of significant sedimentation was observed.

e. Downstream Channel. Two logs were lodged in the channel at the base of the overflow section of the dam. Trees overhang the downstream channel. (See Appendix C - Figure 9.)

3.2 Evaluation

Based on the visual inspection Berry Brook Dam is in fair condition.

a. The large birch tree growing out of the retaining wall on the east bank of the discharge channel immediately downstream of the gatehouse could blow over and cause the retaining wall to fail.

b. The spalling and erosion of the downstream face and construction joint of the east training wall will continue to worsen if not corrected and could affect the stability of the dam in the future.

c. The spalling and erosion of the concrete spillway construction joints could eventually effect the stability of the dam as the erosion worsens, if not corrected.

d. Trees overhanging the discharge channel may blow over into the channel or drop over into the channel as a result of erosion during periods of large discharges from the reservoir. These trees then will cause temporary damming of the channel or they may plug the bridges downstream.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No written procedures exist for Berry Brook Dam. In contacting the Public Works Division of Rochester the following "procedures" were noted. In the spring season while the lake stage is near the crest elevation the 24" outlet pipe is opened. During the winter months the lake stage drops to a very low level and the outlet is closed until spring runoff raises the reservoir again.

4.2 Maintenance of Dam

The Public Works Division of the City of Rochester is responsible for the maintenance of the dam. Maintenance is on an as needed basis.

4.3 Maintenance of Operating Facilities

Maintenance is on an as needed basis.

4.4 Description of Any Warning System in Effect

No warning system exists for the dam.

4.5 Evaluation

The present operational and maintenance procedures are adequate to ensure that minor problems encountered are remedied within a reasonable amount of time. Reliance on oral instructions for maintenance and operations is not altogether satisfactory. Written procedures should be drawn up and utilized.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Berry Brook Dam is a concrete gravity dam which impounds a reservoir of small size. The total length of the dam is 269 feet with a hydraulic height of 24 feet. East of the east end of the dam is a gravelled road. The east abutment is 101 feet in length with a change in alignment after 60 feet. The 12-foot gatehouse is built on the edge of the east spillway abutment. The spillway is 128 feet in length with a sloping downstream face. The west abutment is 39 feet long and is built into sloping natural ground. The watershed above the reservoir is moderate to steeply sloping and heavily wooded. Numerous small storage areas are present in the upstream watershed.

b. Design Data. Plan of proposed dam designed by G.D. Dame, Engineers, 1930 was found. Another plan by same engineer was found of Berry Brook Dam as constructed by Rochester Water Works dated 1930.

c. Experience Data. The Public Works Division of Rochester reported a high water level of 6 inches above the spillway. No other hydrologic or hydraulic data were obtained.

d. Visual Observations. At the time of inspection, no visual evidence of damage to the dam caused by excessive discharges were noted.

e. Test Flood Analysis. Berry Brook Dam is classified as being small in size having a hydraulic height of 24 feet and a maximum storage capacity of 200 acre-feet. The dam was determined to have a significant hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood ranges from the 100-year to ½ the Probable Maximum Flood (PMF).

Because the dam's size is in the lower range of the small size classification and there would probably be no loss of life with a breach of the dam, the test flood was chosen to be ¼ PMF.

In calculating a CSM value for this 3.1 square mile drainage area, several upstream storage areas were taken into account. Based on the drainage area noted in 5.1 a. above and the guide curves, a point between "flat and coastal" and "rolling" was used to compute a PMF CSM value of 1000. This resulted in a test flood inflow of 775 cfs. Routing of this inflow to determine the modifying effects of surcharge storage resulted in an insignificant reduction. Therefore, the routed test flood outflow was determined to be 775 cfs at elevation 478.6' NGVD. The test flood analysis indicates the spillway could pass this flow without causing overtopping of the dam. During the test flood, the depth over the spillway would be 1.6 feet.

f. Dam Failure Analysis. The impact of failure of the dam with the reservoir level at the top of dam was assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to the State Route 202A bridge crossing, a distance of about 2 miles because of the conditions downstream as described in the following paragraph.

A breach of Berry Brook Dam would cause an increase in stage of 8 feet in addition to the 7-foot tailwater stage. The gravel road crossing, located 300 feet downstream of the dam, would be overtopped along its lowest point to a depth of about 8.2 feet. Some damage may result to this roadway hindering its use as an access road. A large swampy area downstream of this crossing, extending to the State Route 202A crossing would attenuate any further effects of a breach.

This reservoir is utilized as the upstream regulating reservoir for use in the Rochester Water Supply System. The Rochester Reservoir is located 3.1 miles downstream. Therefore, loss of Berry Brook Dam may pose a hazard to a public utility and was classified Significant Hazard.

SECTION 6
STRUCTURAL STABILITY

6.1 Visual Observations

The visual examination indicates the following potential structural problems:

a. A large birch tree is growing out of the retaining wall on the east bank of the discharge channel immediately downstream of the gatehouse. If the tree blows over, it could cause the retaining wall to fail.

b. The spalling and erosion of the downstream face and construction joint of the east training wall will continue to worsen if not corrected and could affect the stability of the dam in the future.

c. The spalling and erosion of the concrete spillway construction joints could eventually effect the stability of the dam as the erosion worsens, if not corrected.

d. Trees overhanging the discharge channel may blow over into the channel or drop over into the channel as a result of erosion during periods of large discharges from the reservoir. These trees then will cause temporary damming of the channel or they may plug the bridges downstream.

Because water was flowing over the overflow section of the dam at the time of the inspection it was not possible to determine whether any water was leaking through the foundation of the dam. The report of an inspection made on 7/31/50 indicates that minor seepage under the dam was occurring at that time.

6.2 Design and Construction Data

An inventory report dated 7/24/35 indicates that the dam is founded on "ledge".

6.3 Operating Records

No operating records pertinent to the structural stability of the dam are available.

6.4 Post-Construction Changes

No record of post-construction changes is available.

6.5 Seismic Stability

This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Berry Brook Dam is in fair condition. The major concerns with respect to the condition of the dam, if left uncorrected, are:

(1) A birch tree growing out of the fieldstone retaining wall on the east bank of the discharge channel immediately downstream of the gatehouse.

(2) Spalling and erosion of the downstream face and construction joint at the east training wall.

(3) Surface erosion of the downstream face of the concrete spillway.

(4) Trees overhanging the discharge channel may blow over into the channel or drop over into the channel as a result of erosion during periods of large discharges from the reservoir. These trees then will cause temporary damming of the channel or they may plug the bridges downstream.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

d. Need for Additional Investigation. The information available from the visual inspection is adequate to identify the potential problems which are listed in 7.2 a below. These problems require the attention of a professional engineer experienced in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures to rectify the problems.

7.2 Recommendations

The owner should retain the services of a registered professional engineer to:

(1) Design repairs for the spalling and erosion of the downstream face of the east training wall.

(2) Inspect the concrete spillway face when no water is flowing over the crest and design repairs to correct the erosion of the concrete spillway face.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Maintain clear of trees and brush an area within 25 feet of the downstream toe of the dam and a zone 25 feet wide on both sides of the downstream channel for a distance of 100 feet downstream from the dam.

(2) Repair the joint sealant material in the vertical construction joint in the east training wall.

(3) Ensure the operability of the low-level outlet.

(4) Check the condition of the gate machinery.

(5) Remove debris from the spillway crest.

(6) Inspect for seepage beneath spillway during no flow and monitor if necessary.

(7) Visually inspect the dam and appurtenant structures once a month.

(8) Engage a professional engineer experienced in the design and construction of dams to make a comprehensive technical inspection of the dam once every year.

(9) Establish a surveillance program for use during and immediately after heavy rainfall and also a downstream warning program to follow in case of emergency conditions.

7.4 Alternatives

None recommended.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Berry Brook Dam, N.H. DATE October 25, 1979

TIME 11 AM

WEATHER Clear, cool

W.S. ELEV. U.S. 477.1 DN.S. 457.1

PARTY:

1. [illegible] Gilman (ANCo)
2. Stephen Gilman (ANCo)
3. Leslie Williams (ANCo)
4. Terri Sapp (ANCo)
5. Mehdi Miremadi (ANCo)
6. Kenneth Stern (NHWRB)
7. Ronald Hirschfeld (GEI)
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	L. Williams/T. Sapp	
2.	Structural Stability	S. Gilman	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Berry Brook Dam, N.H. DATE October 25, 1979

PROJECT FEATURE Dam Embankment NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Embankment on both sides of concrete section between east end of overflow section and east abutment.
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	None observed.
Pavement Condition	Not paved.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	Good.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	None observed.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection - Riprap Failures	No riprap.
Unusual Movement or Cracking at or Near Toe	None observed.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None observed.
Vegetation	One tree near east abutment.

PERIODIC INSPECTION CHECKLIST

PROJECT BERRY BROOK DAM, N.H. DATE October 25, 1979

PROJECT FEATURE Dike Embankment NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation - 479.2' MSL	Dike has concrete core wall with earth embankment on both sides.
Current Pool Elevation-477.1' MSL	
Maximum Impoundment to Date	Unknown.
Surface Cracks	None observed.
Pavement Condition	Not paved.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	Good.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	None observed.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection - Riprap Failures	No riprap.
Unusual Movement or Cracking at or Near Toes	None observed.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None observed.
Vegetation	Small trees growing on upstream side of core wall. Large trees growing in channel downstream of dike.

PERIODIC INSPECTION CHECKLIST

PROJECT Berry Brook Dam, N.H. DATE October 25, 1979

PROJECT FEATURE Outlet Structure NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good condition.
Rust or Staining	None visible
Spalling	One chunk, and downstream end of concrete wall.
Erosion or Cavitation	None observed.
Visible Reinforcing	None visible.
Any Seepage or Efflorescence	None visible.
Condition at Joints	Good.
Drain holes	None.
Channel	
Loose Rock or Trees Overhanging Channel	Trees overhanging channel. Fieldstone retaining wall on left bank of channel immediately downstream of gatehouse.
Condition of Discharge Channel	Good.

PERIODIC INSPECTION CHECKLIST

PROJECT Berry Brook Dam, N.H. DATE October 25, 1979

PROJECT FEATURE Spillway Weir NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Not visible beneath reservoir surface.
b. Weir and Training Walls	
General Condition of Concrete	Fair.
Rust or Staining	Only at embedded steel items
Spalling	Minor spalling of surface ½"+ deep exposing coarse aggregate of weir and downstream face. Vertical construction joints spalled and eroded to 3¼ deep maximum. Spalling on several areas on training wall to 1" deep.
Any Visible Reinforcing	
Any Seepage or Efflorescence	Three areas on downstream face of east training wall exhibit seepage & efflorescence.
Drain Holes	None visible.
c. Discharge Channel	
General Condition	Good.
Loose Rock Overhanging Channel	Fieldstone retaining wall on left bank of channel immediately downstream of gatehouse.
Trees Overhanging Channel	Some trees overhanging.
Floor of Channel	Boulders.
Other Obstructions	None.

PERIODIC INSPECTION CHECKLIST

PROJECT Berry Brook Dam, N.H. DATE October 25, 1979

PROJECT FEATURE Control Tower NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	Part of concrete dam and spillway.
a. Concrete and Structural	
General Condition	Good.
Condition of Joints	Good, no indication of movement.
Spalling	A little surface spalling on top of concrete. Walls are good.
Visible Reinforcing	None.
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	None visible.
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	Not open for inspection.
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PROJECT Berry Brook Dam

DATE October 25, 1979

PROJECT FEATURE Reservoir

NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good.
Sedimentation	Not visible.
Changes in Watershed Runoff Potential	None.
Upstream Hazards	None.
Downstream Hazards	Dirt road 300 feet downstream of the dam.
Alert Facilities	None posted.
Hydrometeorological Gages	None.
Operational & Maintenance Regulations	None posted.

APPENDIX B

ENGINEERING DATA

State of New Hampshire

WATER RESOURCES BOARD

37 Pleasant Street

Concord, N.H. 03301

TELEPHONE 271-3406

3/5

February 14, 1978

Rochester Water Board
Rochester, NH 03867

Gentlemen:

Under the provisions of RSA Chapter 482, Sections 8 through 15, copy enclosed, on December 2, 1977 an Engineer of the Water Resources Board inspected your dam in Farmington. This dam, #83.06, is classified in the files of this office as a menace structure and as such must be maintained in a manner not to endanger public safety nor become a dam in disrepair.

As a result of this inspection it was noted that several items of maintenance are in need of attention.

1. To keep the spillway clear of trees and debris.

2. To check for any possible leaks on the downstream side of spillway during the summer and report it to this office.

If you have any questions, please contact us at your convenience.

Very truly yours,

George McGee Sr.

George M. McGee, Sr.
Chairman

GMM:PEK:njk

Encl.

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: Farmington Dam Number: 83.06

Name of Dam, Stream and/or Water Body: Berry's River

Owner: Rochester Water Board Telephone Number:

Mailing Address: Rochester

Max. Height of Dam: 27.5 Pond Area: 22.75 acres Length of Dam: 265'

FOUNDATION: Concrete on ledge

OUTLET WORKS: Gate Sections
Water supply for Rochester

ABUTMENTS: Concrete

EMBANKMENT: Earth

Note: Give Sizing, Condition and detailed description for each item, if applicable.

SPILLWAY: Length: 124' Freeboard: 2.5'

SEEPAGE: Location, estimated quantity, etc.

None

Changes Since Construction or Last Inspection:

None

Tail Water Conditions:

Fair

Overall Condition of Dam: Good

Contact With Owner: No

Date of Inspection: 12/2/77 Suggested Reinspection Date 1978

Class of Dam: Menace

Signature [signature]

Date 12/2/77

Note: Give Sizing, Condition and detailed description for each item, if applicable.

Dam No. _____

COMMENTS: Water about 5" over spillway
Cannot inspect any leaks
at the foot of the spillway

NEW HAMPSHIRE WATER RESCURCES BOARD

INSPECTION REPORT

Town: Farmington Dam Number: 83.06

Name of Dam, Stream and/or Water Body: Bennett River

Owner: Rochester Water Board Telephone Number:

Mailing Address: Rochester

Max. Height of Dam: 27.5 Pond Area: 22.75 acres Length of Dam: 265'

FOUNDATION: concrete on ledge

OUTLET WORKS: Gate section
Water supply for Rochester

APPURTENANTS: Concrete

EMBANKMENT: Earth

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Farmington DAM NO. 83.06 STREAM Branch Berry's River

OWNER City of Rochester Water Dept. ADDRESS Rochester, N.H.

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 7/31/50 ~~accompanied by~~

NOTES ON PHYSICAL CONDITION

Abutments Good

Spillway Good - minor seepage under spillway on ledge foundation.

Gates Operable

Other

CHANGES SINCE LAST INSPECTION None

FUTURE INSPECTIONS Yes

This dam (is) ~~(is not)~~ a menace because of head & spillage

REMARKS Water down about 5' from spillway.

Copy to Owner	Date

INSPECTOR

(Additional Notes Over)

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 83.08

Town Farmington : County Strafford

Stream Berry's River

Basin-Primary Ocean : Secondary Isinglass River

Local Name

Coordinates—Lat. 43° 20' -5700 : Long. 71° 5' -400

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 4.54 Sq. Mi.

Overall length of dam 265.24 ft.: Date of Construction

Height: Stream bed to highest elev. 27.5 ft.: Max. Structure 25' ft.

Cost—Dam : Reservoir

DESCRIPTION Gravity- Concrete- Ledge

Waste Gates

Type

Number : Size ft. high x ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on : Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction Concrete

Length—Total ft.: Net 134' 10" ft.

Height of permanent section—max. 25' ft.: Min. ft.

Flashboards—Type None : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 1890 cfs.: 416 cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 2.5 ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Rochester Water Works

Conservation

REMARKS Use- Conservation

B-7

Tabulation By A.A.N.&R.L.T. Date November 29, 1938.

7205

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 83.06

Town Farmington : County Strafford

Stream Berry's River

Basin—Primary Ocean : Secondary Isinglass River

Local Name

DRAINAGE AREA

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total ..... Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Head Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height			
(2) Top of Flashboards			
(3) Permanent Crest			
(4) Normal Drawdown		22.75	
(5) Max. Drawdown			
(6) Original Pond	U S G S 500		

Base Used .....: Coef. to change to U.S.G.S. Base .....

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	ft.	ft.
Volume	ac. ft.	ac. ft.
Acre ft. per sq. mi.		
Inches per sq. mi.		

USE OF WATER Conservation

OWNER Rochester Water Works

REMARKS

Tabulation By A.A.N.&R.L.T. Date November 30, 1938.

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Ocean NO. 6 — 60 — I-4510
RIVER Berry's MILES FROM MOUTH D.A.SQ.MI. 4.54
TOWN Farmington OWNER Rochester Water Board
LOCAL NAME OF DAM
BUILT DESCRIPTION Gravity — Concrete on Ledge

POND AREA-ACRES 22.75 DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. 27.5 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 265.27 MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. LOCAL GAGE
TAILWATER ELEV.U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 124.833 FREEBOARD-FT. 2.5
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST None
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

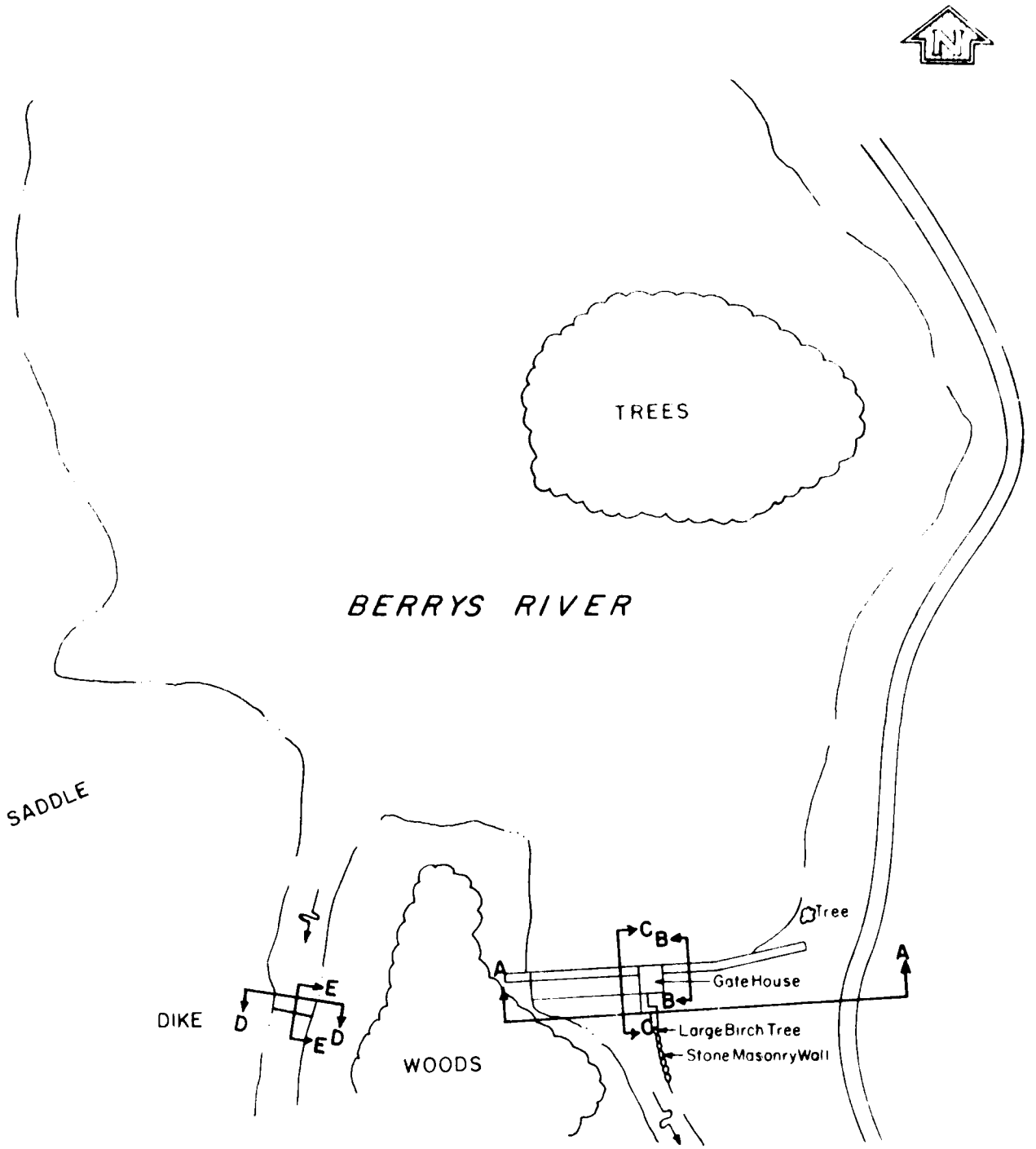
REMARKS Condition Good

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

USE Conservation

REMARKS Not in use



Anderson · Nichols & Co, Inc	U S ARMY ENGINEER DIV NEW ENGLAND
CONCORD NEW HAMPSHIRE	CORPS OF ENGINEERS WALTHAM, MA

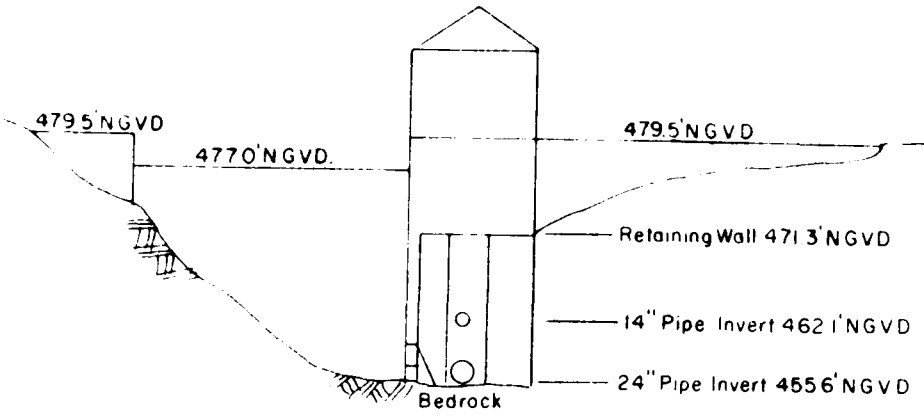
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

BERRY BROOK DAM

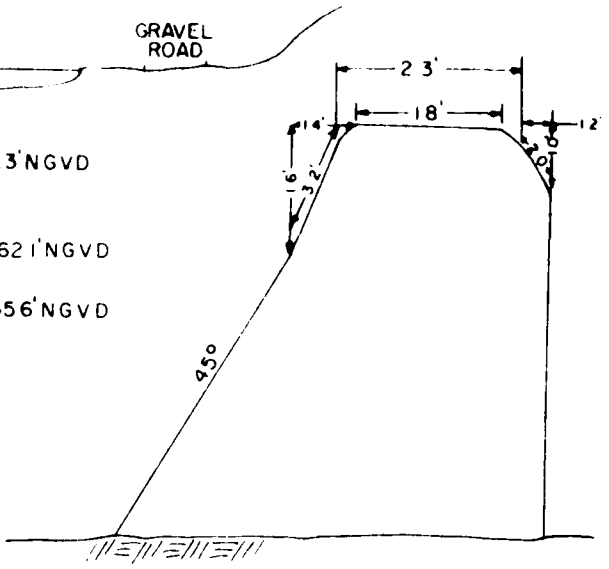
BERRYS RIVER NEW HAMPSHIRE

SCALE NOT TO SCALE

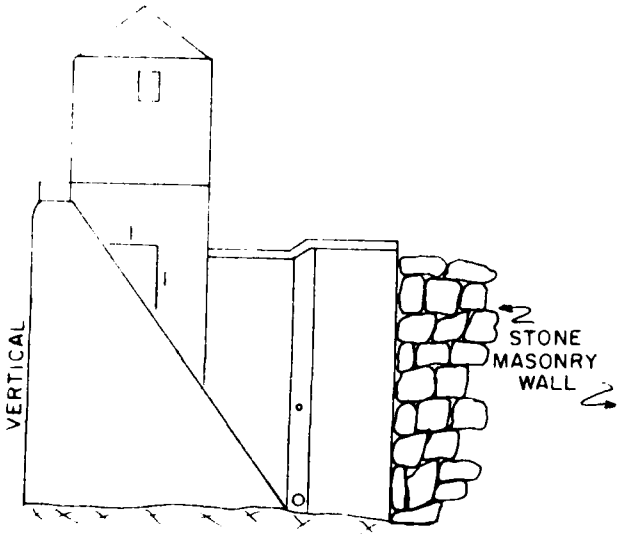
DATE DECEMBER 1979



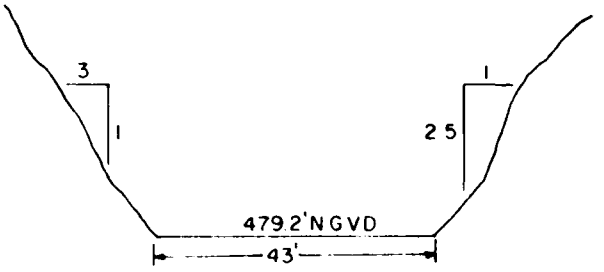
ELEVATION A-A



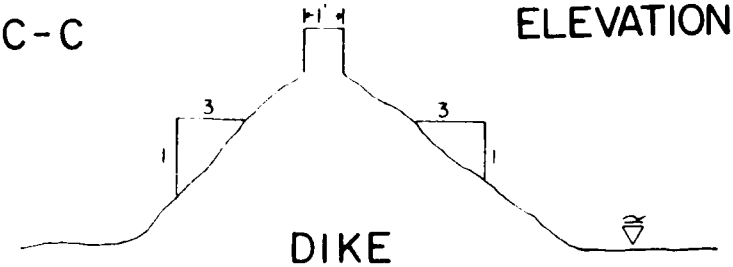
ABUTMENT
CROSS SECTION B-B



SPILLWAY
CROSS SECTION C-C



DIKE
ELEVATION D-D



DIKE
CROSS SECTION E-E

Anderson-Nichols & Co, Inc CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

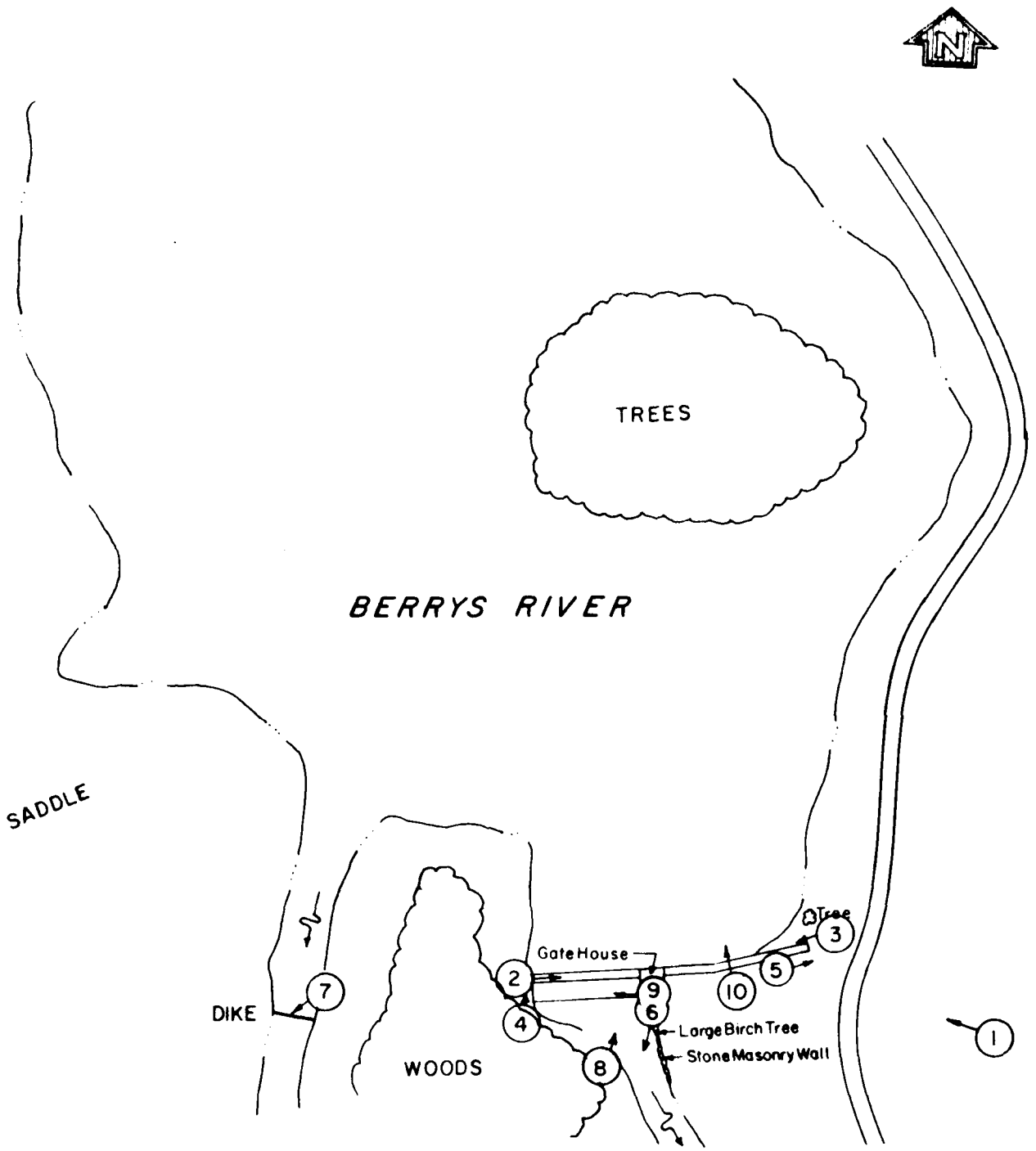
BERRY BROOK DAM

BERRYS RIVER NEW HAMPSHIRE

			SCALE NOT TO SCALE
			DATE DECEMBER 1979

APPENDIX C

PHOTOGRAPHS



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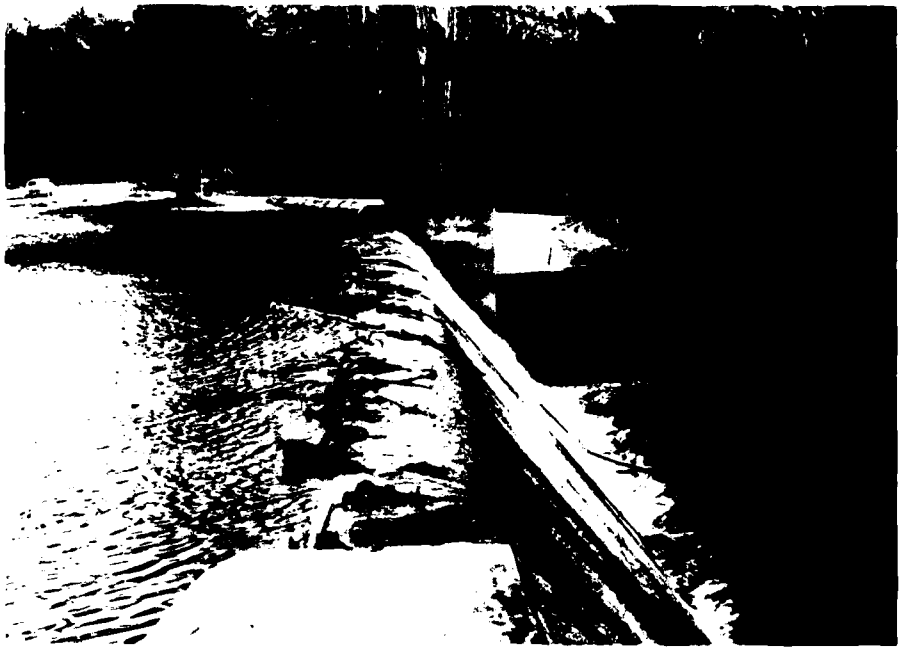
CONCORD NEW HAMPSHIRE	CORPS OF ENGINEERS WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PHOTO INDEX

BERRYS RIVER **NEW HAMPSHIRE**

SCALE	NOT TO SCALE
DATE	DECEMBER 1979



October 25, 1979
Figure 2 - Looking east along spillway crest from west abutment. Note large pine tree growing in earthfill near east abutment.

October 25, 1979
Figure 3 - Looking at the east abutment of the dam.

October 25, 1979

Figure 4 - Looking north at west abutment. Note trees.

October 25, 1979

Figure 5 - Looking at the east end of the dam. Note gravel roadway.

October 25, 1979

Figure 6 - Looking west across downstream face of spillway. Note bedrock exposures at toe.

October 25, 1979

Figure 7 - View of the dike located 150 feet west of the west abutment of the dam.

October 25, 1979

Figure 8 - View of the retaining wall.

October 25, 1979

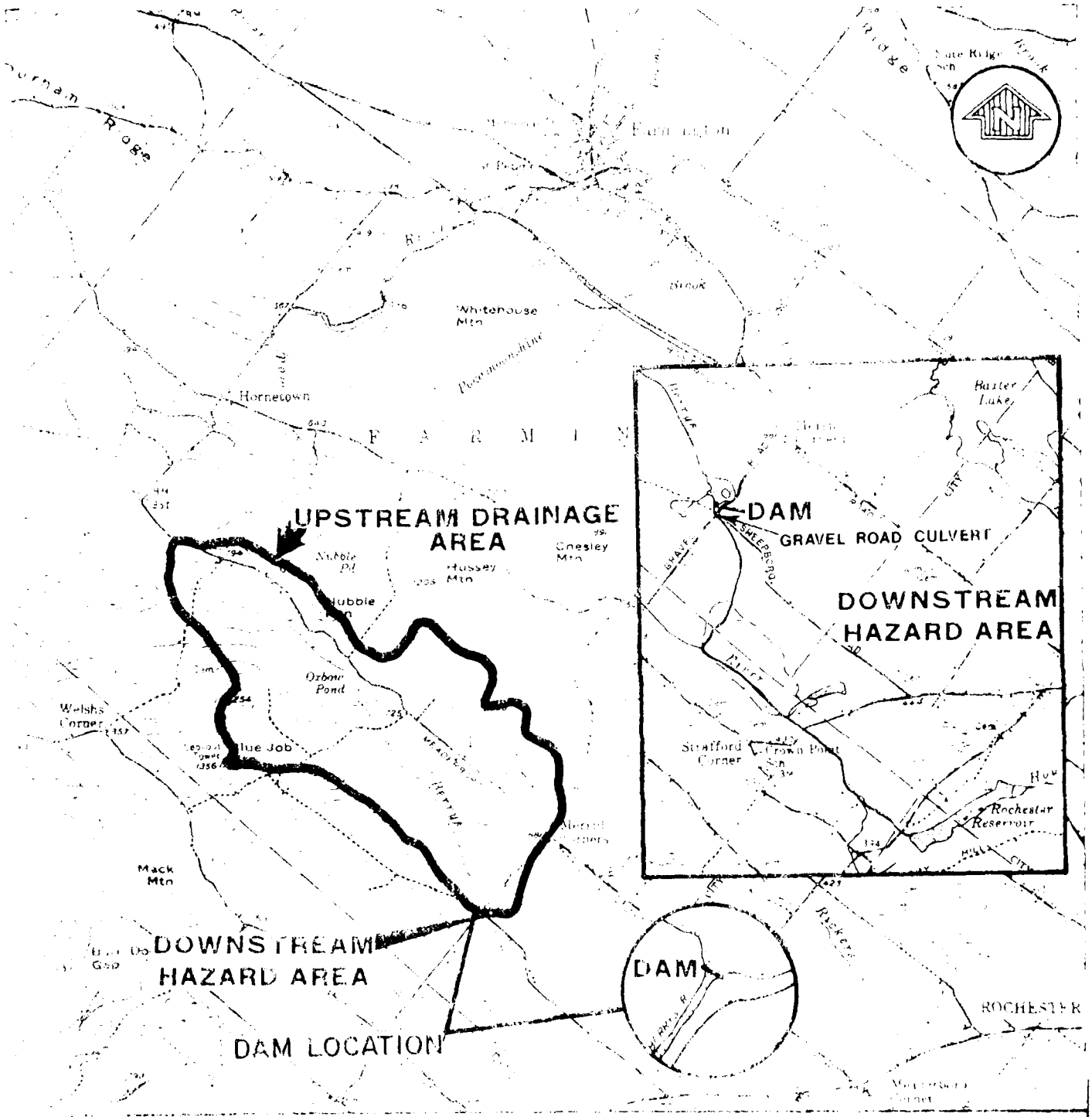
Figure 9 - View of the downstream channel. Note large birch tree growing out of fieldstone retaining wall.

October 25, 1979

Figure 10 - Looking into upstream reservoir from the dam.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



REGIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BERRY BROOK DAM

FARMINGTON, NEW HAMPSHIRE

REGIONAL VICINITY MAP

DECEMBER 1979

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

METCALF & EDDY, INC. CONCORD, NH

SCALE IN MILES

1 0 1 2

MAP BASED ON U.S.G.S. 15 MINUTE QUADRANGLE SHEET ALTON, N.H. 1957

Anderson-Nichols & Company, Inc.

Subject BREACH ANALYSIS

Sheet No. 1 of 25
Date 10/27/79
Computed LSW
Checked

JOB NO. 3273-21 BERRY BROOK DAM

UARES IN. SCALE

BREACH ANALYSIS - Assume breach with water surface elevation @ top of dam (479.2' MSL) to determine downstream hazard potential.

Assume water @ 479.2' MSL
Upstream toe @ 467.4' MSL
Downstream end spillway @ 457' MSL (left end)
Downstream end spillway @ 469' MSL (right end)

$Q_{P1} = 8/27\ W_b \sqrt{g}\ y_o^{3/2}$ where:

W_b = breach width
g = 32.2 ft/sec^2
y_o = pool elev - bed

For Berry Brook Dam:

Breach width would most likely occur at the spillway section. Therefore the breach width is the length of spillway which is 128 feet. y_o will be measured from pool elev of 479.2' MSL to the downstream end of the spillway which is about 463' MSL

$Q_{P1} = 8/27 (128) \sqrt{g} (6.2)^{3/2}$
$= 4030$ cfs

Use a typical cross section representing the reach from the dam 3000 feet downstream to the upstream limit of large cultivated areas. This reach will be called Reach #1. Develop

D-2

Anderson-Nichols & Company, Inc.

Subject _____

Sheet No. 2 of 25
Date 11/21/79
Computed LW
Checked _____

JOB NO.

this section uses the Manning's Equation which is

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$ where

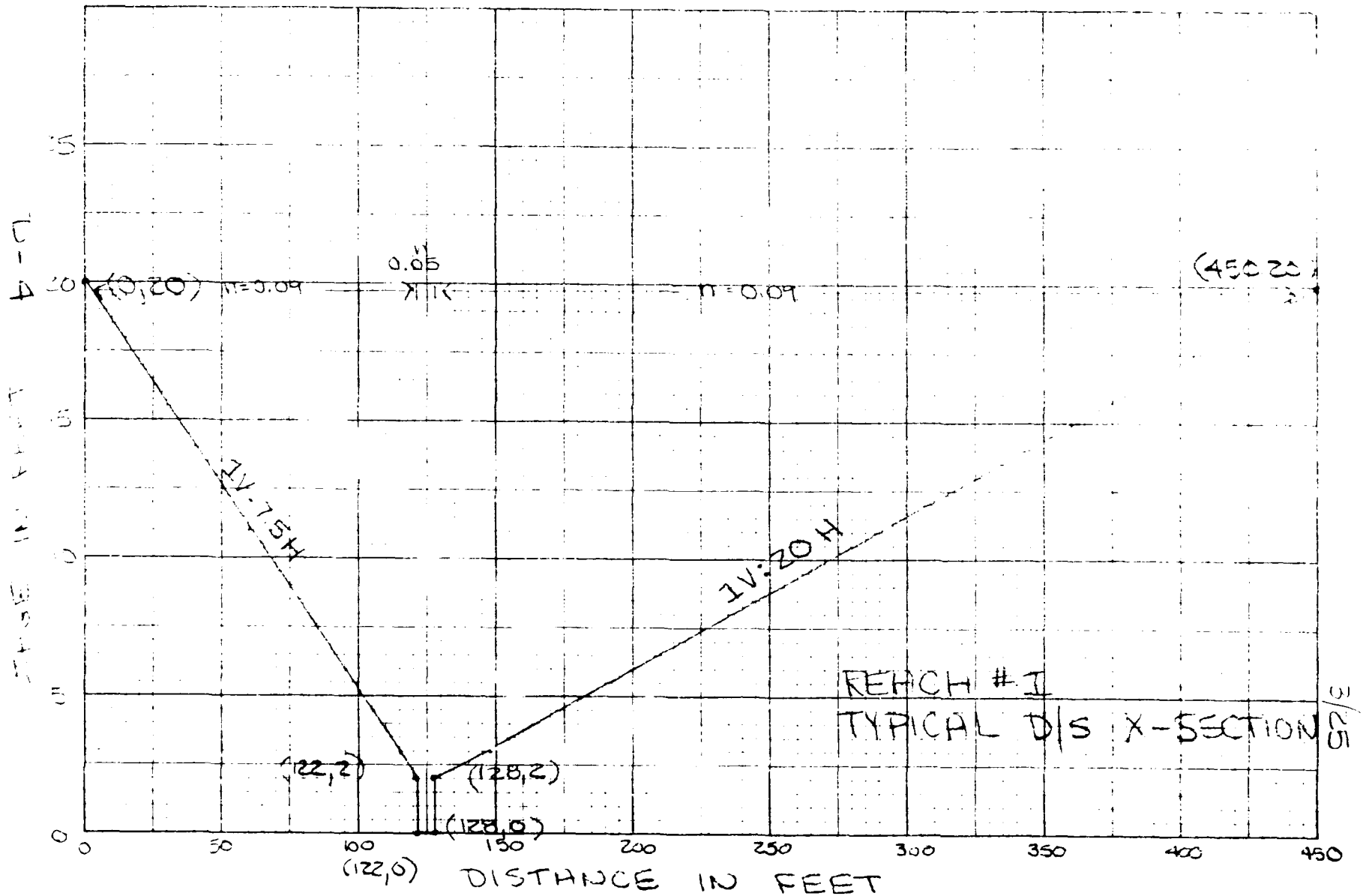
n = 'n' value roughness coefficient
A = area of section in square feet
R = area/wetted perimeter
S = slope of reach

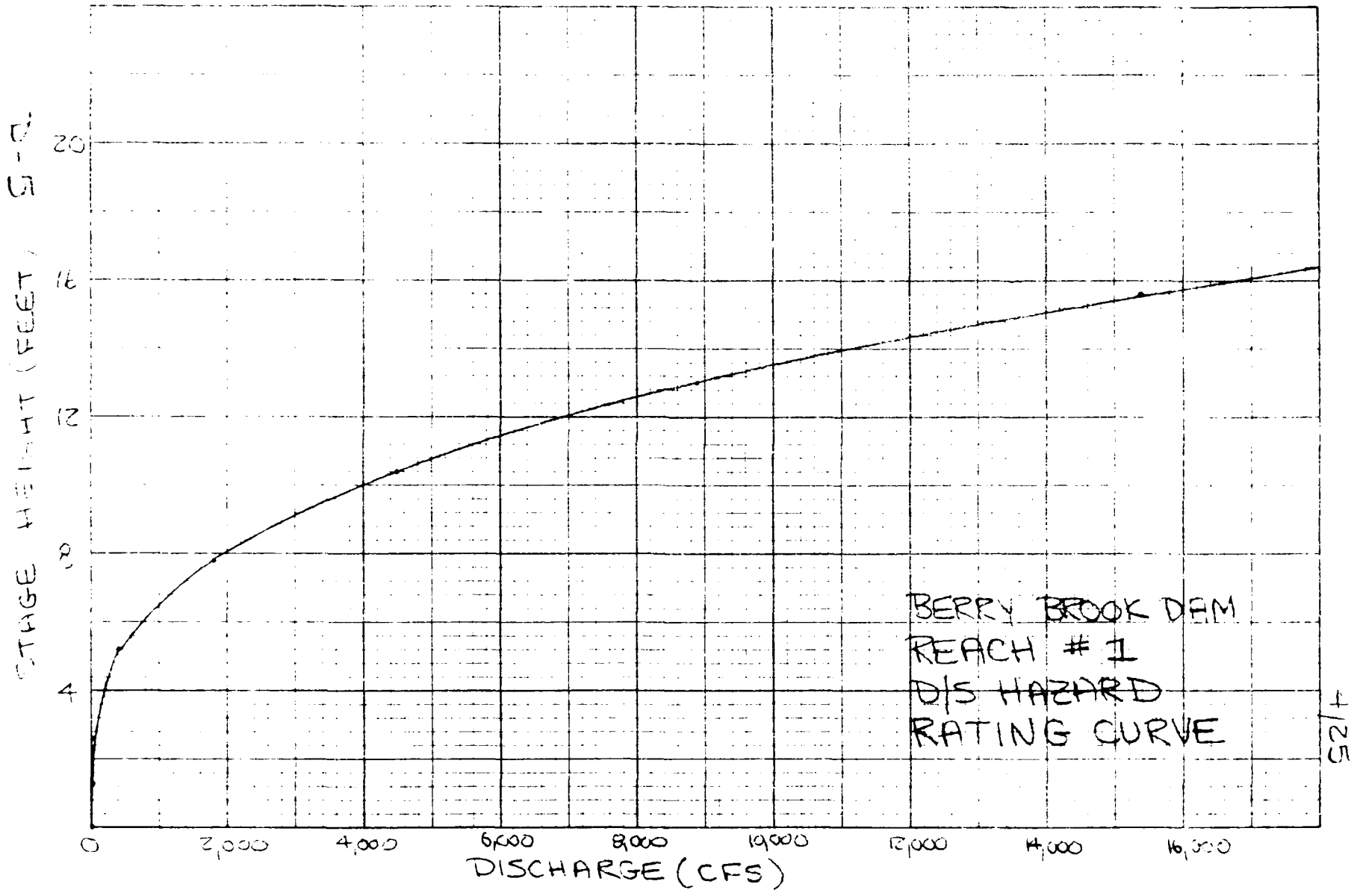
Length of reach = 2000 feet
U/S toe of dam = 457' MSL
stream invert end of reach #1 = 440' MSL
Slope of reach = 0.009
n' for channel = 0.05
n' for overbanks = 0.09

The following table was generated using a Commodore Pet 2001 desk computer. Manning's Equation for open channel flow was programmed into the computer.

DEPTH	AREA	Q
0	0	0
1.3	8	21
2.6	20.8	37
5.2	160.3	437
7.8	466.7	1775
10.4	939.8	4477
13.0	1579.6	8908
15.6	2386.2	15,397

Note the above data is input into the single precision [illegible].


(0,20)
n=0.09
0.05
n=0.09
(450,20)
1V:1.5H
1V:2.0H
(122,2)
(128,2)
(128,0)
(122,0)
0
5
10
15
20
0
50
100
150
200
250
300
350
400
450
DISTANCE IN FEET
REACH #1
TYPICAL D/S X-SECTION


STAGE HEIGHT (FEET U.S.G.D.)
20
16
12
8
4
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
DISCHARGE (CFS)
BERRY BROOK DAM
REACH # 1
D/S HAZARD
RATING CURVE

S2/4

Refer to Rating Curve - REACH #1
Antecedent discharge = 1255 cfs
Stage @ 1255 cfs = 7 feet

Peak Q = 14,000 cfs
Stage @ 14,000 cfs = 15 feet

Use of REACH #1 provides no storage effects in reducing breach Q. Therefore an increase in stage of 8 feet in REACH #1 could be anticipated upon breach.

Analyze the capacity of the stone box culvert located about 300 feet downstream of the dam. (The wooden stream crossing about 100 feet downstream of the dam will not be analyzed. It was assumed this structure would be washed out and not provide any storage.)

Develop a rating curve using the weir cross section shown on page .

Stage 0' Q = 0 cfs

Stage @ 1.2' Low flow through culvert just before overtopping of road. This flow was estimated using the Manning equation: $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$Q = \frac{1.49}{0.035} 11.2 (3.48)^{2/3} (0.01)^{1/2}$

Q = 954 cfs

Stage @ 8.5' Pressure flow through culvert and weir flow over roadway.

Pressure flow: $Q = CA\sqrt{2gh}$

$Q = 0.8(113.4)\sqrt{2(32.2)4.3}$

$Q = 1500$ cfs

Weir flow: $Q = CLH^{3/2}$

$Q = 2.7(1/2\,18)(1.3)^{3/2} + 2.7(40)(1.3)^{3/2} + 2.7(1/2\,32)(1.3)^{3/2}$

$= 260$ cfs

Total Q = 1760 cfs

Stage @ 10.0' Pressure flow through culvert and weir flow over roadway.

$Q = 0.8(113.4)(\sqrt{64.4 \times 5.8})$

$Q = 1755$ cfs

$Q = 2.7(1/2\,40)(2.8)^{3/2} + 2.7(40)(2.8)^{3/2} + 2.7(1/2\,70)(2.8)^{3/2}$

$= 1200$ cfs

Total Q = 2955 cfs

Stage @ 15.0' Pressure flow through culvert and weir flow over roadway.

$Q = 0.8(113.4)\sqrt{64.4 \times 10.8}$

$= 2390$ cfs

SQUARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 26 26 27 28 29
1 IN. SCALE

Stage 15.0' cont.

Weir flow = $2.7(2110)(7.8)^{3/2} +$
$2.7(40)(7.8)^{3/2} + 2.7(\frac{1}{2}40)(5.1)^{3/2} +$
$2.7(25)(5.1)^{3/2} + 2.7(70)(6.4)^{3/2}$
$Q = 10,050$ cfs

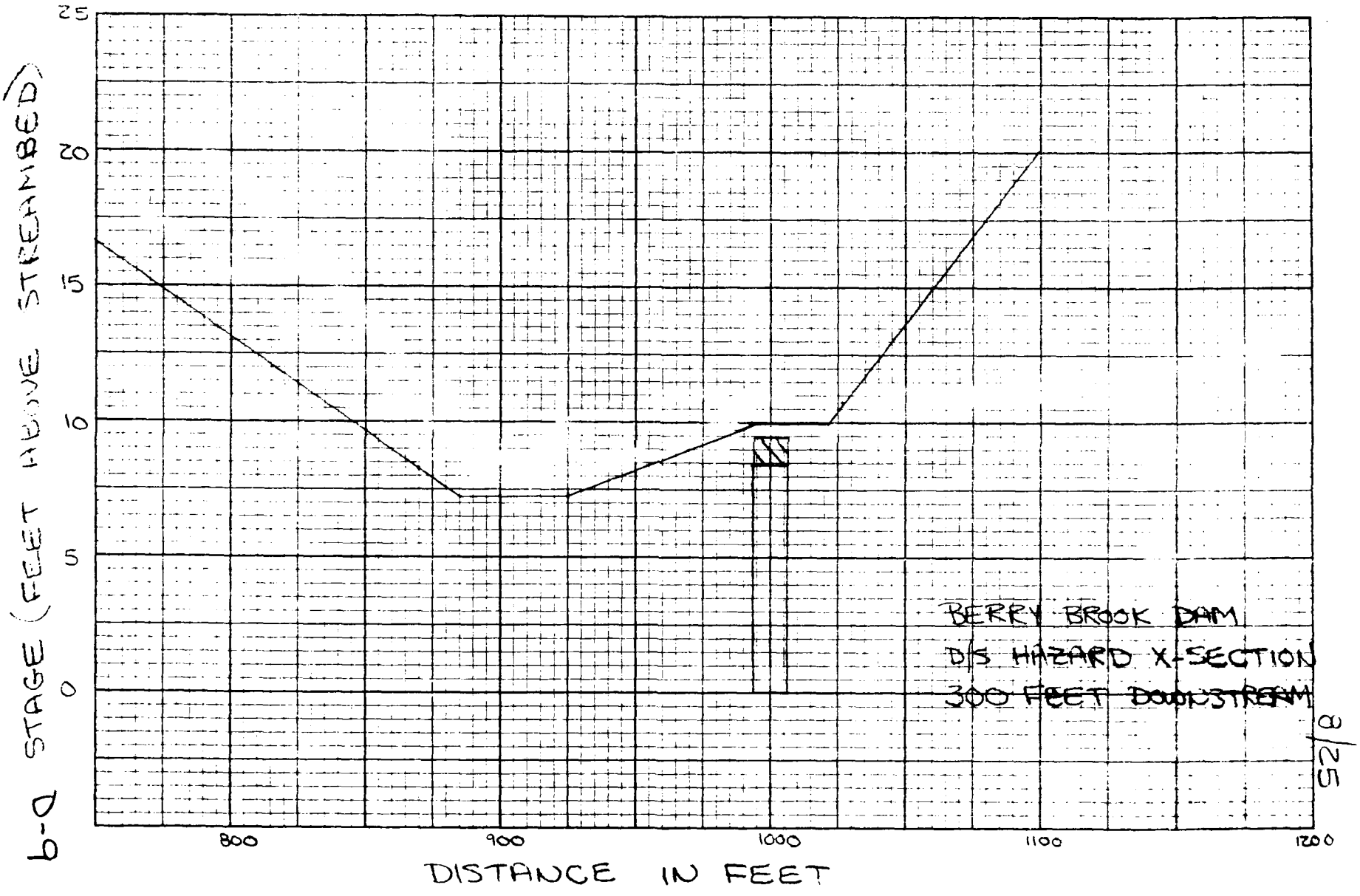
Total Q = 12,440 cfs

Use the above trials to develop a rating curve for this road crossing located about 300 feet downstream of the dam.

Refer to the rating curve:
Antecedent discharge = 1255 cfs
Stage @ 1255 cfs = 7.8 feet

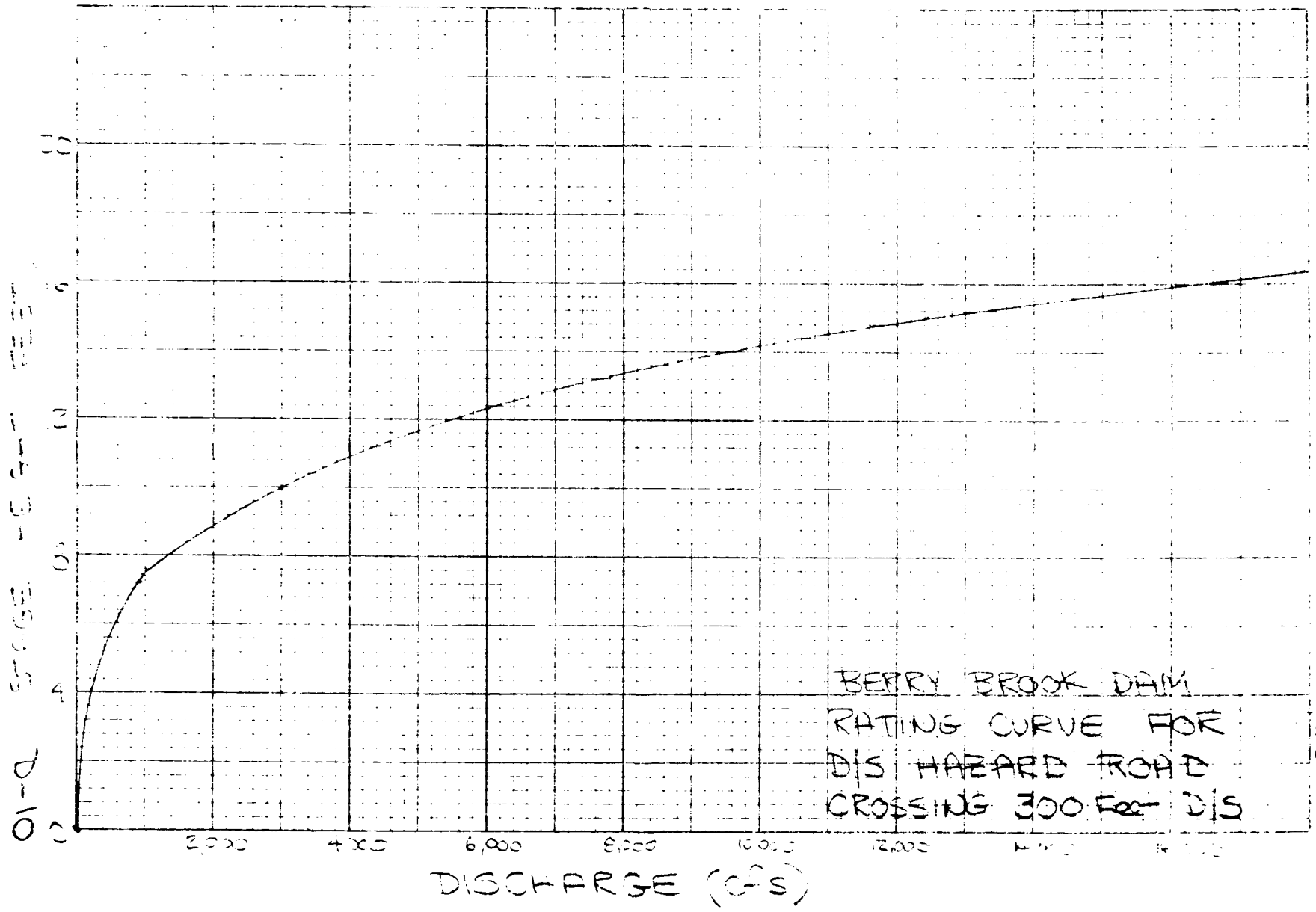
Breach discharge = 14,030 cfs
Stage @ 14,030 cfs = 15.4 feet

Therefore, breach would cause an increase in stage of 7.6 feet. The roadway would be overtopped by about 8.2 feet.


25
20
15
10
5
0
800
900
1000
1100
1200
STAGE (FEET ABOVE STREAMBED)
DISTANCE IN FEET
BERRY BROOK DAM
D/S HAZARD X-SECTION
300 FEET DOWNSTREAM

52/8

b-9


BERRY BROOK DAM
RATING CURVE FOR
D/S HAZARD ROAD
CROSSING 300 FEET D/S
DISCHARGE (CFS)
STAGE - ELEVATION

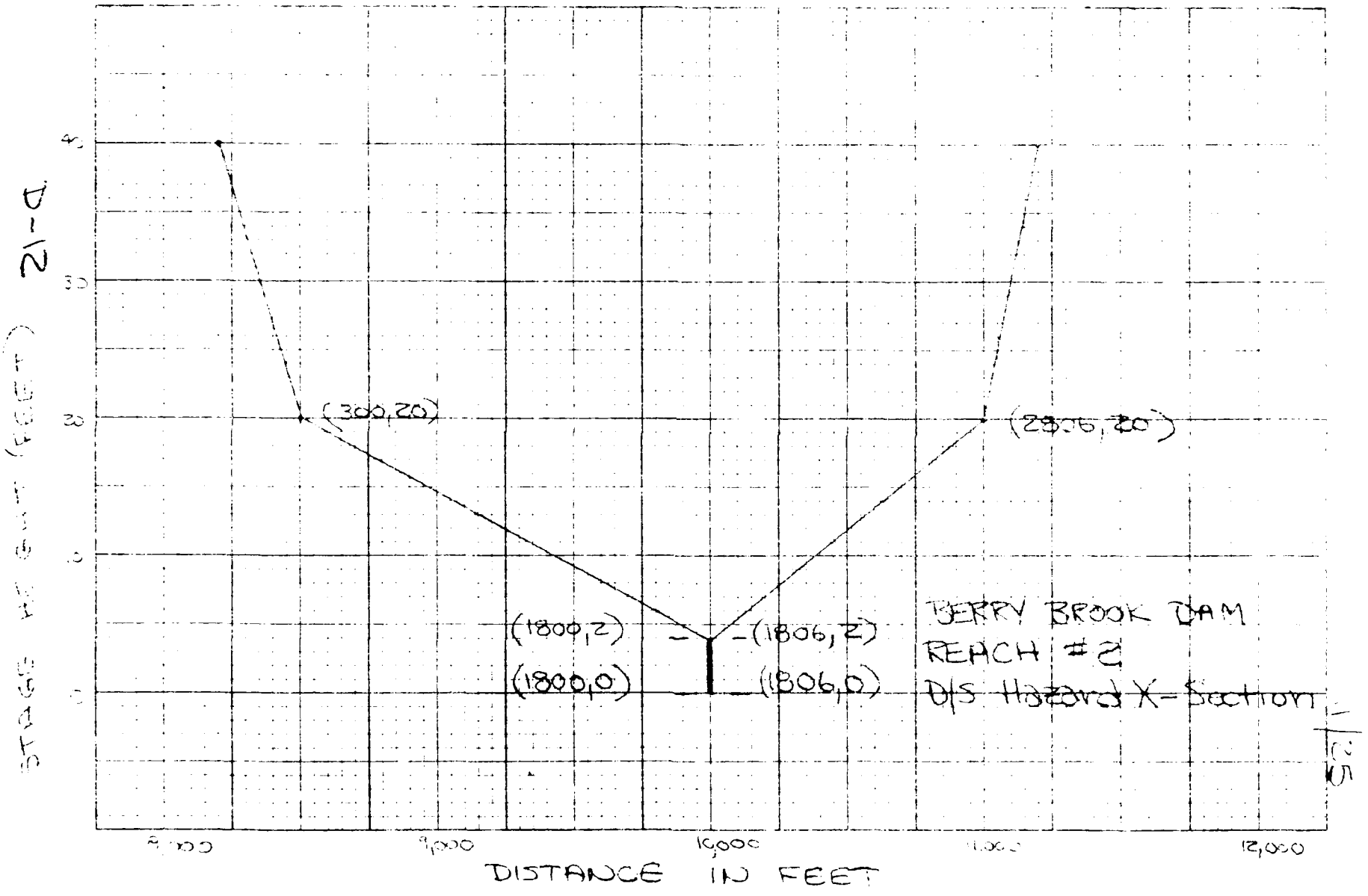
REACH #2 Develop a stage-discharge relationship for a typical cross section through the swampy area to the crossing of State Route 202A, a distance of about 8700 feet. A typical cross section is shown on page .

Length of reach = 8700 feet
Elev. start of reach = 440' MSL
Elev. end of reach = 415' MSL
Slope of reach = 0.003
Due to swampy nature of section a composite 'n' value of 0.055

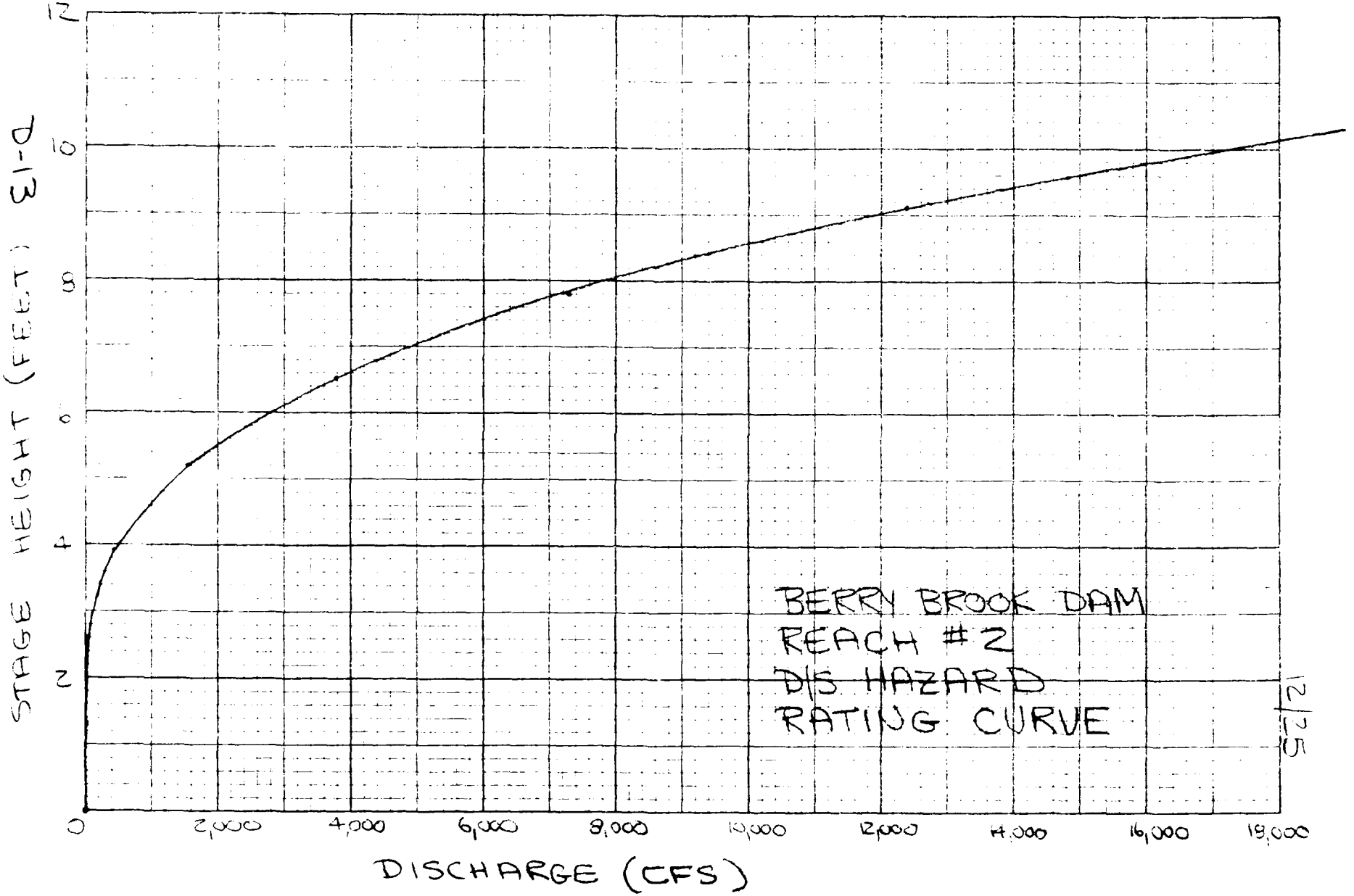
The following table was generated using a Commodore Pet 2001 desk computer, programmed with the Manning Equation.

DEPTH	AREA	DISCHARGE
0	0	0
1.3	3	11
2.6	43.65	37
3.9	283.8	424
5.2	757.4	1563
6.5	1466.36	3761
7.8	2410.04	7283
9.1	3588.44	12,367
10.4	5001.56	19,235

Use the above trials to develop a stage discharge curve for REACH #2.


STAGE IN FEET (FEET)
40
30
20
0
0
(300,20)
(2806,20)
(1800,2)
(1806,2)
(1800,0)
(1806,0)
BERRY BROOK DAM
REACH #2
D/S Hazard X-Section
9,000
10,000
12,000
DISTANCE IN FEET

21-D


STAGE HEIGHT (FEET)
0
2
4
6
8
10
12
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
DISCHARGE (CFS)
BERRY BROOK DAM
REACH #2
D/S HAZARD
RATING CURVE
12/25

D-13 31-D

Anderson-Nichols & Company, Inc.

Subject

Sheet No. 13 of 25
Date 11/26/79
Computed SW
Checked

JOB NO.

REACH #2 This reach will provide storage effects.

Storage @ top of dam = _____ ac ft
Q_{p1} = 14,030 cfs

Storage @ 477 (spillway crest) = 160 ac-ft
Surface area @ 477 = 15 acres
Average storage depth = 10.67 ft
Depth @ u/s face of spillway = 10 ft
Difference 160 ac-ft [illegible]

Surface area @ 480 = 25 acres

Using 'Frustrum of Pyramid Equation'

$$V = \frac{1}{3}h\left(b_1 + b_2 + \sqrt{b_1 b_2}\right)$$

(b_1 = normal surface area; b_2 = elevation 480 surface area)

$$V = \frac{1}{2}3\left(15 + 25 + \sqrt{15 \times 25}\right)$$
$$= 60 \text{ ac-ft}$$

Storage @ 480 = 160 + 60 = 220 ac-ft

Top of dam = 479.2' MSL
Storage = 200 ac-ft

$Q_{1-2} = Q_{p1} - \frac{1}{3}$, where 1 = [illegible] reach [illegible]

For 1:
Q_{p1} = 14,030 cfs = [illegible] ft
Use @ 9 ft storage = [illegible]
Storage [illegible] = 22 ac-ft × 43,560 sq ft/ac = 713 ac-ft

Based on the storage capacity of the swamp, a breach of Berry Brook Dam would be attenuated in this area.

HAZARD CONCLUSIONS:

A breach of Berry Brook Dam would cause an increase in stage of 8 feet in addition to the 7-foot tailwater stage. The unnamed road crossing, located 300 feet downstream of the dam, would be overtopped along its lowest point to a depth of about 8.2 feet. Some damage may result to this roadway hindering its use as an access road. A large swampy area downstream of this crossing extending to the State Route 202A crossing would attenuate any further effects of a breach.

This reservoir is utilized as the upstream regulating [illegible] for use in the Rochester [illegible] System. The Rochester [illegible] 3.1 miles downstream [illegible] of Berry Brook Dam [illegible] to a public [illegible] Significant [illegible]

BERRY BROOK D-14

Drainage Area = 3.1 square miles
The drainage area for this dam is reduced to the 4.54 square miles. Visual inspection of the area west of the lake, where water is known to drain to Crystal Lake revealed the following:

1) The main dam outlet for this drainage area is approximately 2 miles on the U.S.G.S. Quadrangle Alton, N.H. The dam is located at the southern tip of the lake, not at the eastern tip as shown on quad. Discharge from the dam enters Berrys River downstream of Berry Brook Dam.

2) Where the outlet is shown on the quad exists a 2.5'H x 4'W stone masonry box culvert. A road runs over this culvert. The only flow which would enter the drainage behind Berry Brook Dam would be the small amount of seepage through this culvert. Flow over this culvert would go down road into channel. The DA for this smaller lake was planimetered to be 0.8 square miles.

Size Classification: Small
Maximum Storage Capacity = 200 ac-ft
Hydraulic Height (479.2 - 455.6) = 24 feet

Hazard Classification: Significant

Test flood range: 100-yr ≯ ½ PMF

STEP #1

According to COE guidance, the 100-yr is roughly equivalent to ¼ the Probable Maximum Flood (PMF).

Slope of watershed ≈ 102 ft/mi
Change in elev 810-477 = 333 ft
length of basin = 3.25 mi
Due to the existence of some storage upstream and the elongated nature of the watershed the rolling curve will be used to define the PMF CSM value.

PMF Inflow:
3.1 mi^2 x 2000 CSM = 6200 cfs
Test Flood = ¼ PMF
Test Flood Inflow = 1550 cfs

Another method to calculate the estimated 100-year frequency flow is use of the Benson's Equation*. This equation was derived from the study of the relation of hydrologic characteristics to flood peaks within a humid region of the United

* Factors Influencing the Occurrence of Floods in a Humid Region of Diverse Terrain by Manuel A. Benson.

States, the New England Region was utilized for this study area.

The equation follows:

$Q_T = a A^b S^c St^d I^e t^f O^g$ where

Q_T = T-year annual peak discharge (cfs)
A = drainage area
S = main channel slope (feet per mile)
St = percent of surface storage area plus 0.5 percent
I = T-year 24-hour rainfall intensity in inches
t = average January degrees below freezing in degrees Fahrenheit
O = orographic factor
a,b,c,d,e,f,g = regression coefficients

For Berry Brook Dam:

Q_T = 100-year
A = 3.1 mi^2
S = 102 ft/mi
St = 7.5 percent
I = 6.3 inches *
t = 10°
O = 1.0

* Obtained from Technical Paper No. 40, Rainfall Frequency Atlas of the United States, prepared by David Hershfield for Engineering Division, U.S. Dept of Hydrology, Washington, D.C. May 1961.

$$Q_T = aA^bS^cSt^dI^et^fO^g$$
$$100\,yr = 1.38(3.1)^{.9}(102)^{.4}(7.5)^{-.3}(6.3)^{1.1}(10)^{-.6}(1.0)^{1.2}$$
$$100\,yr = \underline{400\ cfs}$$

Due to the large difference these two methods obtained another regional method was used. The State of N.H., Dept. of Public Works and Highways utilizes the NEHL Method (New England Hill and Lowland Area). Using this method the following results were obtained:

$$Q_{10} = 280\ cfs$$
$$Q_{50} = 1.74(Q_{10})^{1.007} = 1.74(280)^{1.007} = 507\ cfs$$
$$Q_{100}(\text{extrapolated}) = \underline{620\ cfs}$$

Both regional equations show that a CSM value of 2000 is too large for this particular basin. Analysis of these results shows that a CSM value of 1000 would be reasonable. Therefore:

PMF Inflow = 3.1 x 1000 = 3100 cfs
¼ PMF (Test Flood) = 775 cfs (Q_{p_1})

STEP #2a. Determine Surcharge Height to pass Q_{p_1} = 775 cfs

To do this a rating curve for Berry Brook Dam must be calculated. Flow would begin over the spillway; higher water would outflow at other low outlets around the lake. The unit section and

elevations are shown on the cross sections plotted on pages 21 & 22.

Flow over these weirs can best be approximated with use of the WEIR EQUATION: $Q = CLH^{3/2}$. All 'C' values were used with consultation to the King and Brater, Handbook of Hydraulics, Sixth Edition.

The following is a list of all outflow areas, their crest elevation, and location.

1) Main Spillway Crest - 477.0' MSL
Spillway Abutments - 479.5' MSL

2) Natural Saddle is located west of the main dam and dike. Its crest elevation is about 478.8' MSL. Dischavge over this area would join the main dischavge channel just downstream of the dam. Because this is not a structure or a part of the dam this low area will not define the 'top of dam' in the following H/H analysis.

3) A dike with a concrete wall is located 175 feet west of the west main dam abutment. Its crest elevation is about 479.2' MSL.

4) A roadway runs northeast along the reservoir shore. The crest of this road where outflow could occur is 479.4' MSL.

DISCHARGE CALCULATIONS

Assume elev 477.0' MSL Q = 0 cfs

Assume elev @ 477.5' MSL
$Q = 3.0(128)(0.5)^{3/2} = 135$ cfs

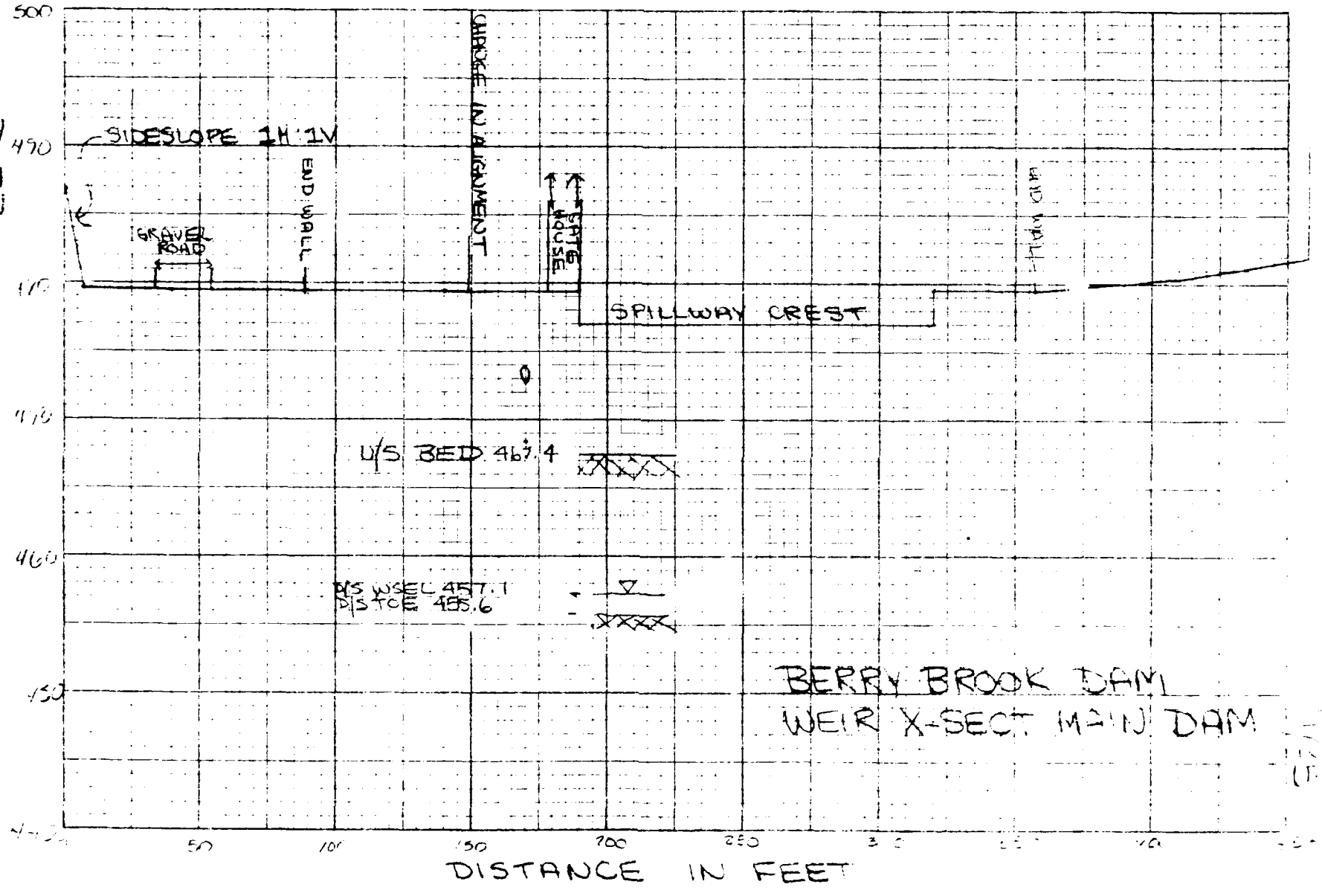
Assume elev @ 478.0' MSL
$Q = 3.0(128)(1.0)^{3/2} = 385$ cfs

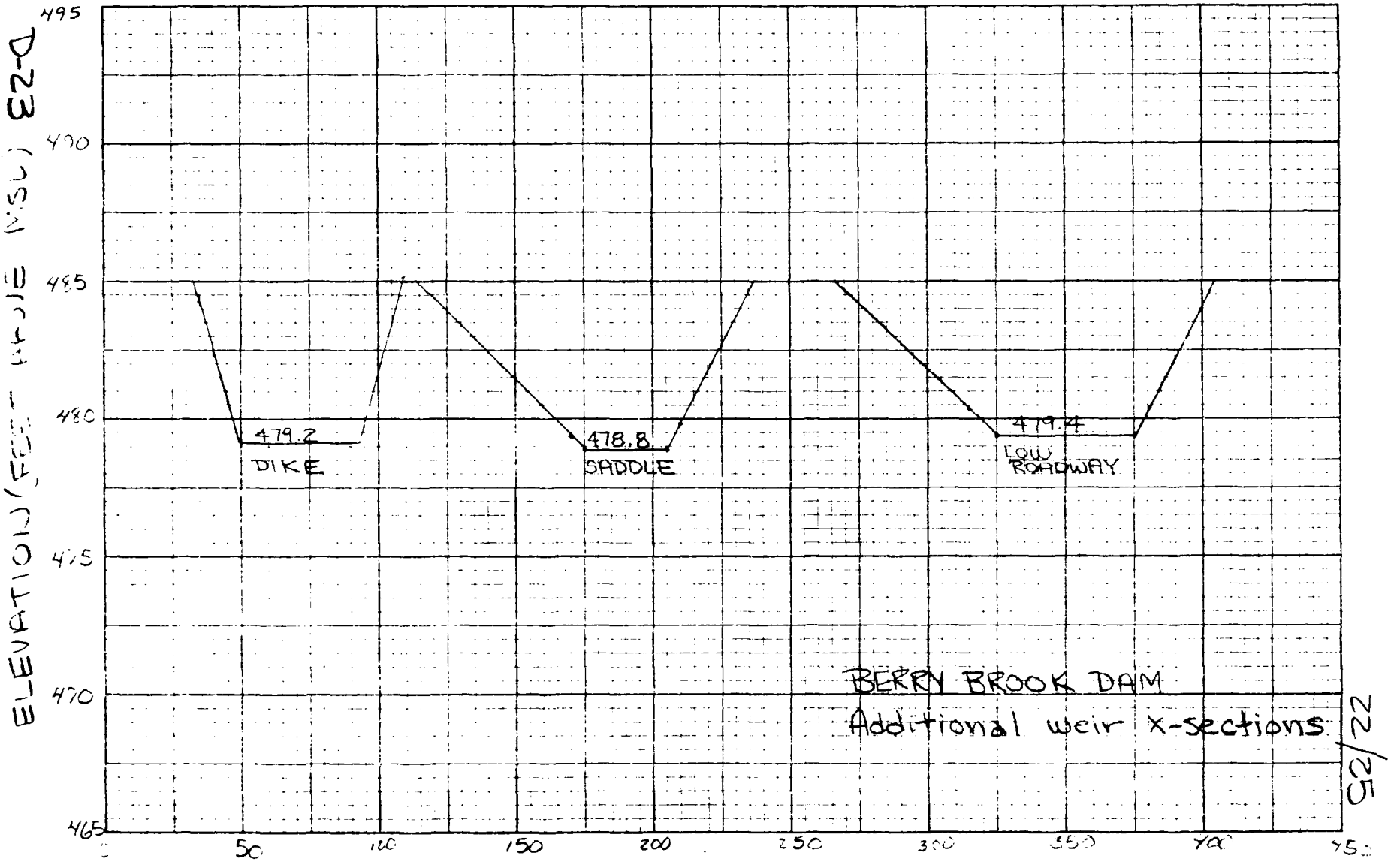
Assume elev @ 478.8' MSL - To saddle crest
$Q = 3.0(128)(1.8)^{3/2} = 930$ cfs

Assume elev @ 479.2' MSL - To dike crest which will be referred to as 'top of dam'
$Q_{(SPILLWAY)} = 3.0(128)(2.2)^{3/2} = 1255$ cfs
$Q_{(SADDLE)} = 2.6(30)(0.4)^{3/2} = 20$ cfs
Total Q = 1275 cfs

Assume elev @ 479.4' MSL - To low roadway crest
$Q_{(SPILLWAY)} = 3.0(128)(2.4)^{3/2} = 1430$ cfs
$Q_{(SADDLE)} = 2.6(30)(0.6)^{3/2} = 35$ cfs
$Q_{(DIKE)} = 2.7(43)(0.2)^{3/2} = 10$ cfs
1475 cfs

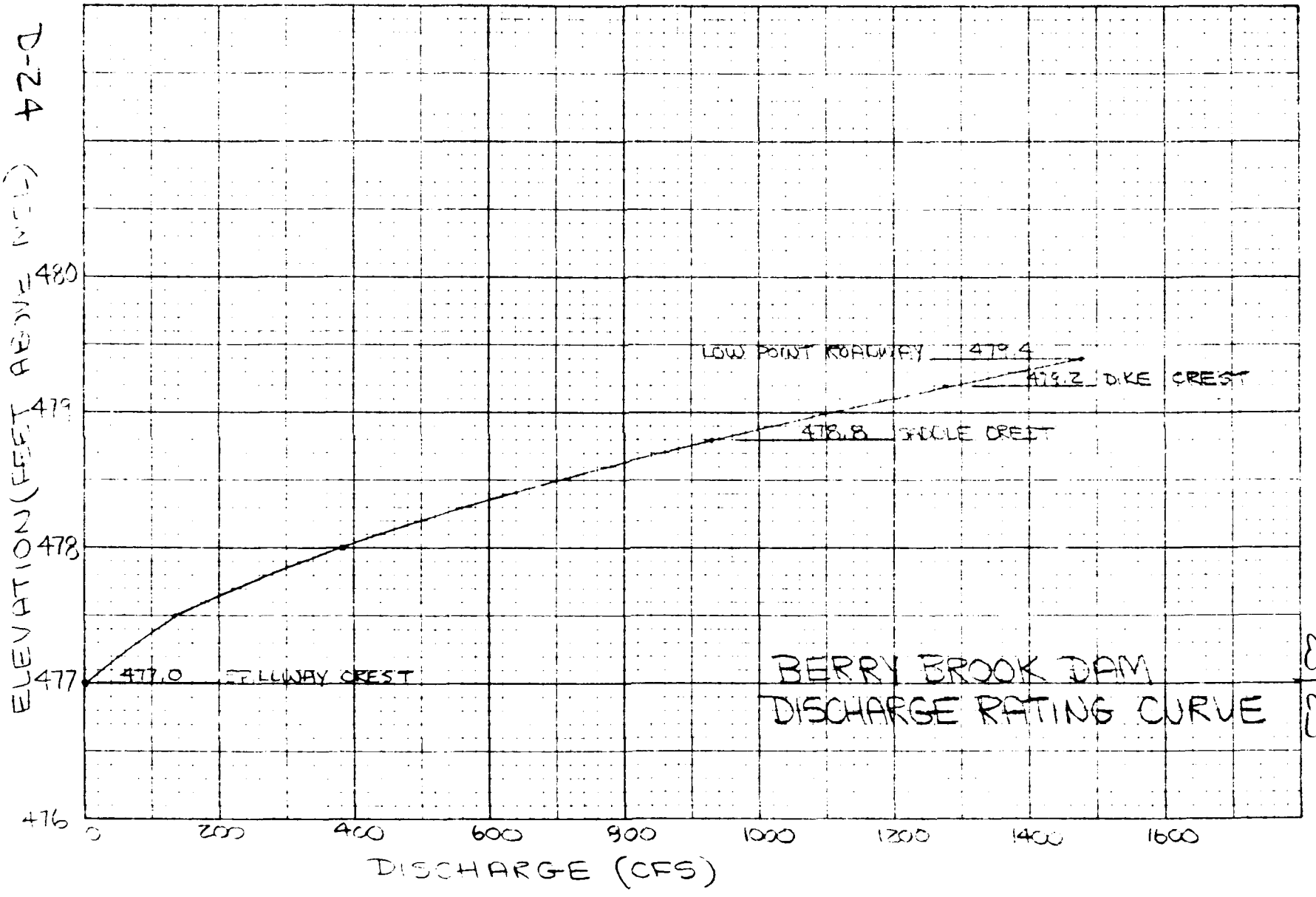
Using the above trials establish a discharge rating curve for Berry Brook Dam.


D-22
ELEVATION (FT. ABOVE MSL)
500
490
470
460
450
SIDESLOPE 1H 1V
GRAVEL ROAD
END WALL
CHANGE IN ALIGNMENT
STATE HOUSE
SPILLWAY CREST
U/S BED 467.4
U/S WSEL 457.1
D/S TOE 455.6
BERRY BROOK DAM
WEIR X-SECT. MAIN DAM
50
100
150
200
250
DISTANCE IN FEET



BERRY BROOK DAM
Additional weir x-sections

52/22



BERRY BROOK DAM
DISCHARGE RATING CURVE

23/25

Q_{P_1} = 775 cfs ⇒ 478.6' MSL

STEP #2b Determine volume of surcharge in inches of runoff.

Using the storage values computed for the Tuesday analysis sheet 13.

@ 477' MSL Storage = 160 ac-ft
@ 480' MSL Storage = 220 ac-ft

Find Storage @ 500' MSL

SA = acres

$V = \frac{1}{3} 20 (25 + 55 + \sqrt{25 \cdot 55})$,

= 780

Storage @ 500' MSL = 1000 AC-FT

Use the above points to establish a storage/elevation curve.

Q_{P_1} = 775 cfs ⇒ 478.6' MSL ⇒ 190 ac-ft

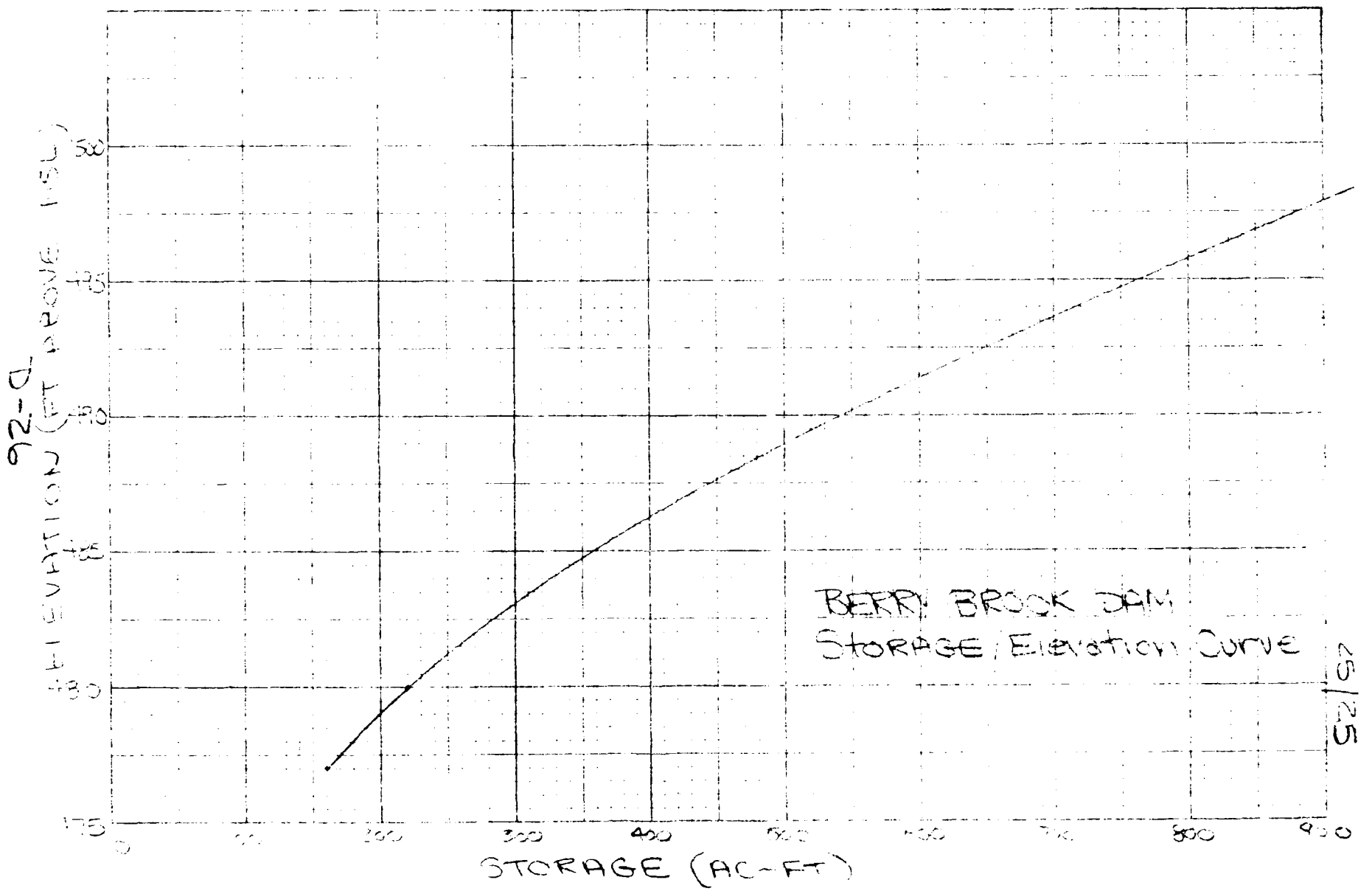
$30 \text{ AC-FT} \cdot \frac{1}{3.1 \text{ mi}^2} \cdot \frac{1 \text{ mi}^2}{640 \text{ AC}} \cdot \frac{12 \text{ in}}{\text{FT}} = 0.18''$ runoff (STOR$_1$)

STEP #2c

$Q_{P_2} = Q_{P_1}\left(1 - \frac{\text{STOR}_1}{19}\right) = 775\left(1 - \frac{0.18}{19}\right) = 770$ cfs

Surcharge storage is negligible therefore 775 cfs inflow ≈ outflow.

The dam will not be overtopped by the test flood. Test flood will discharge 1.6 feet over spillway crest.


92-D
ELEVATION (FT ABOVE 1540)
500
475
450
425
400
375
0
100
200
300
400
500
600
700
800
900
STORAGE (AC-FT)
BERRY BROOK DAM
STORAGE / ELEVATION CURVE
52/57

Anderson-Nichols & Company Inc Subject: [illegible] capacities

JOB NO.

Sheet No. 1 of 1
Date 12/5/79
Computed CW
Checked

Determine approximate pipe capacities [illegible] @ 477' MSL.

<u>[illegible]</u> ([illegible] outlet)

Q of Orifice = $CA\sqrt{2gh}$

Invert = [illegible] MSL ℄ 462.68

$A = \pi r^2 =$ [illegible]

$Q = CA\sqrt{2gh}$

$= (0.8)(1.07)(\sqrt{64.4 \times 14.32})$

<u>= 26 cfs</u>

<u>24-inch</u> (low-level outlet)

Invert ≈ 455.6' MSL ℄ = 456.6' MSL

Area = 3.14

$Q = (0.8)(3.14)(\sqrt{64.4 \times 20.4})$

<u>= 90 cfs</u>

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

END

FILMED

8-85

DTIC